MINX Document 5
Measuring Aerosol Height and Motion with MINX

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Contents

- Parallax, disparity and image matching
- Height/wind retrieval algorithm
- MINX height retrieval comparisons
- Digitizing procedure
- Evaluating results

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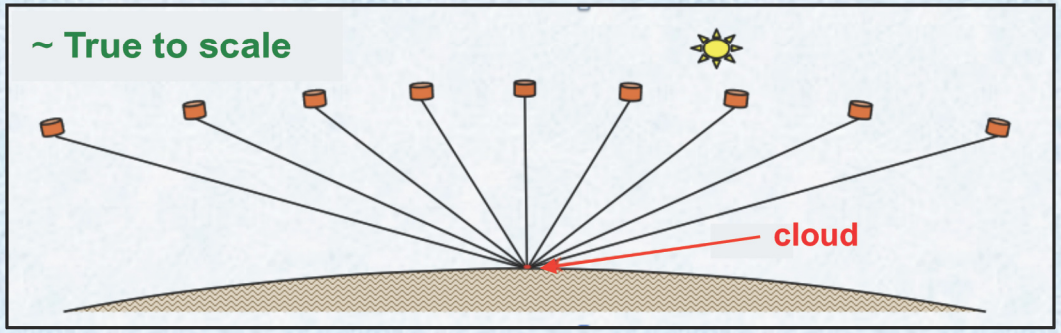
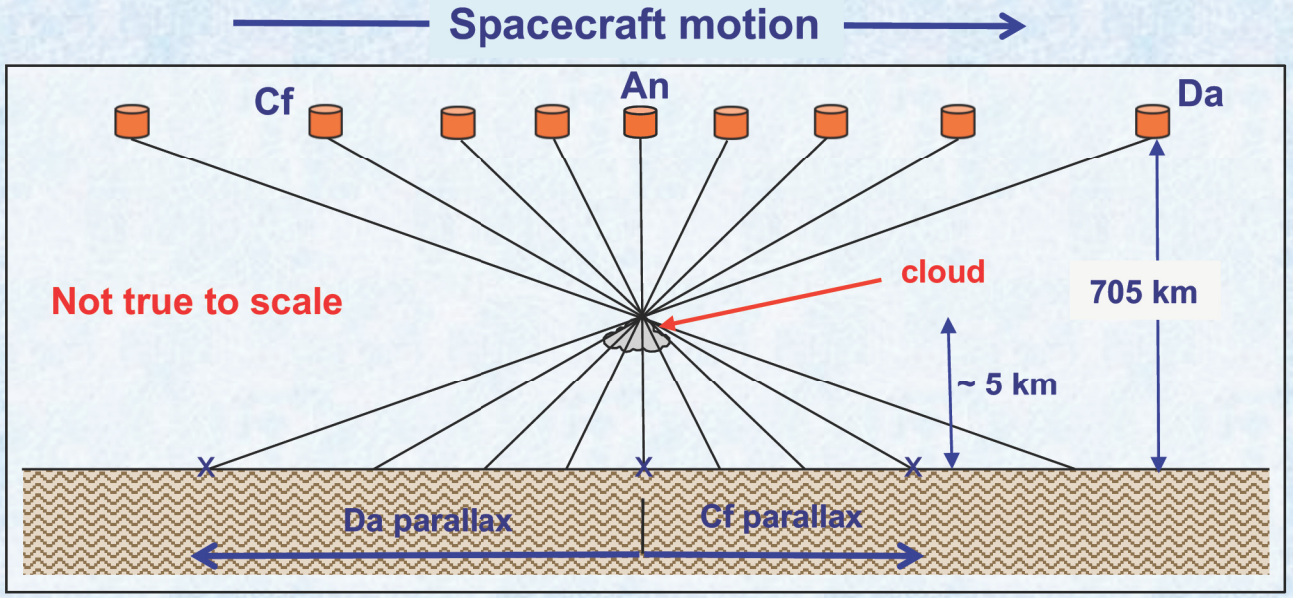
Parallax

Parallax is a difference in the apparent position of an object viewed along different lines of sight. Nearby objects have larger parallax than more distant objects, so parallax can be used to determine distance.

MISR geometry when all cameras view a stationary cloud

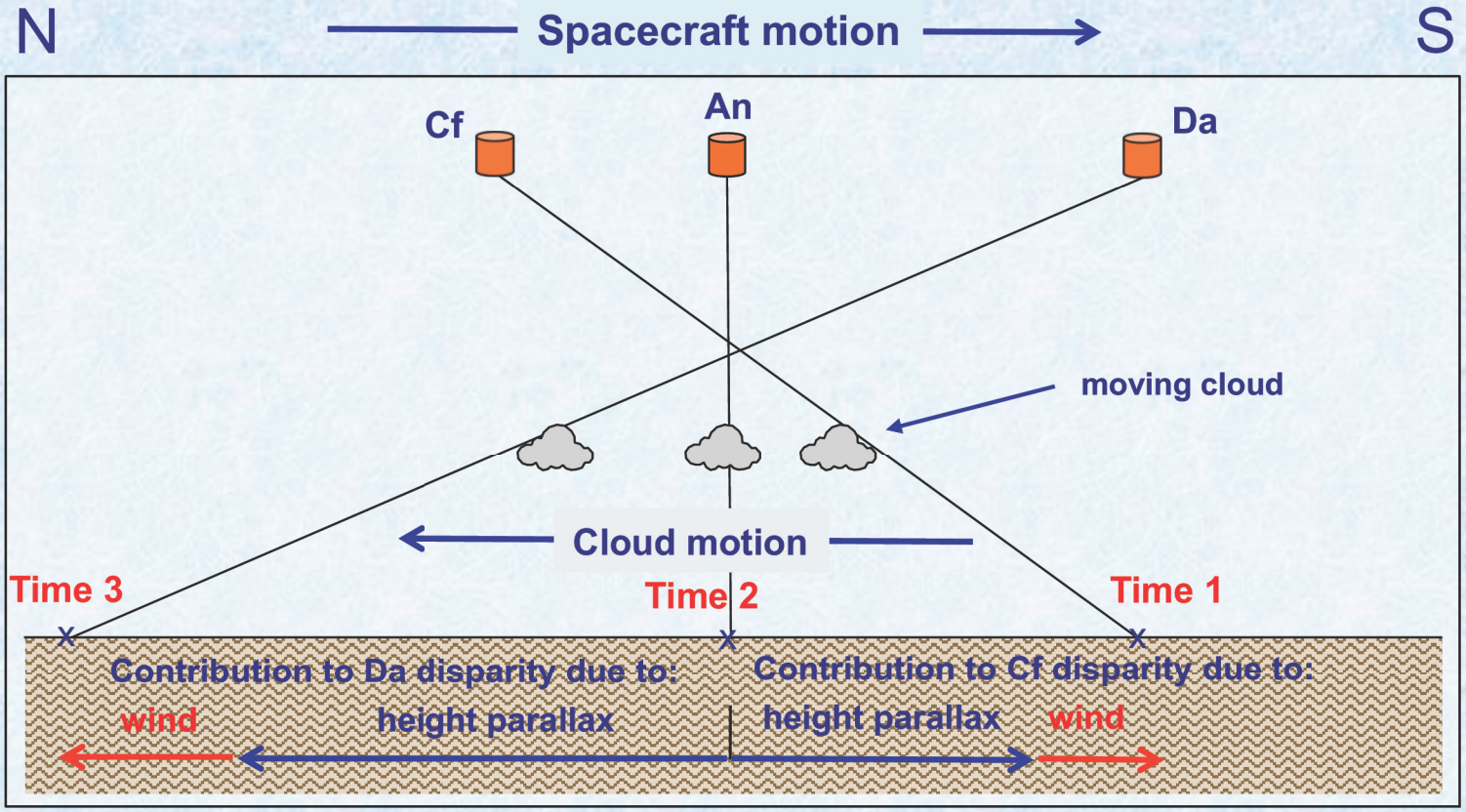




Da and Cf camera parallax relative to An camera

Disparity - 1

Disparity is closely related to parallax. It is the measure of total offset in the apparent position of an object viewed along different lines of sight due to actual movement of the object in addition to height parallax. In MINX, the direction of cloud (or plume) motion is input by user.

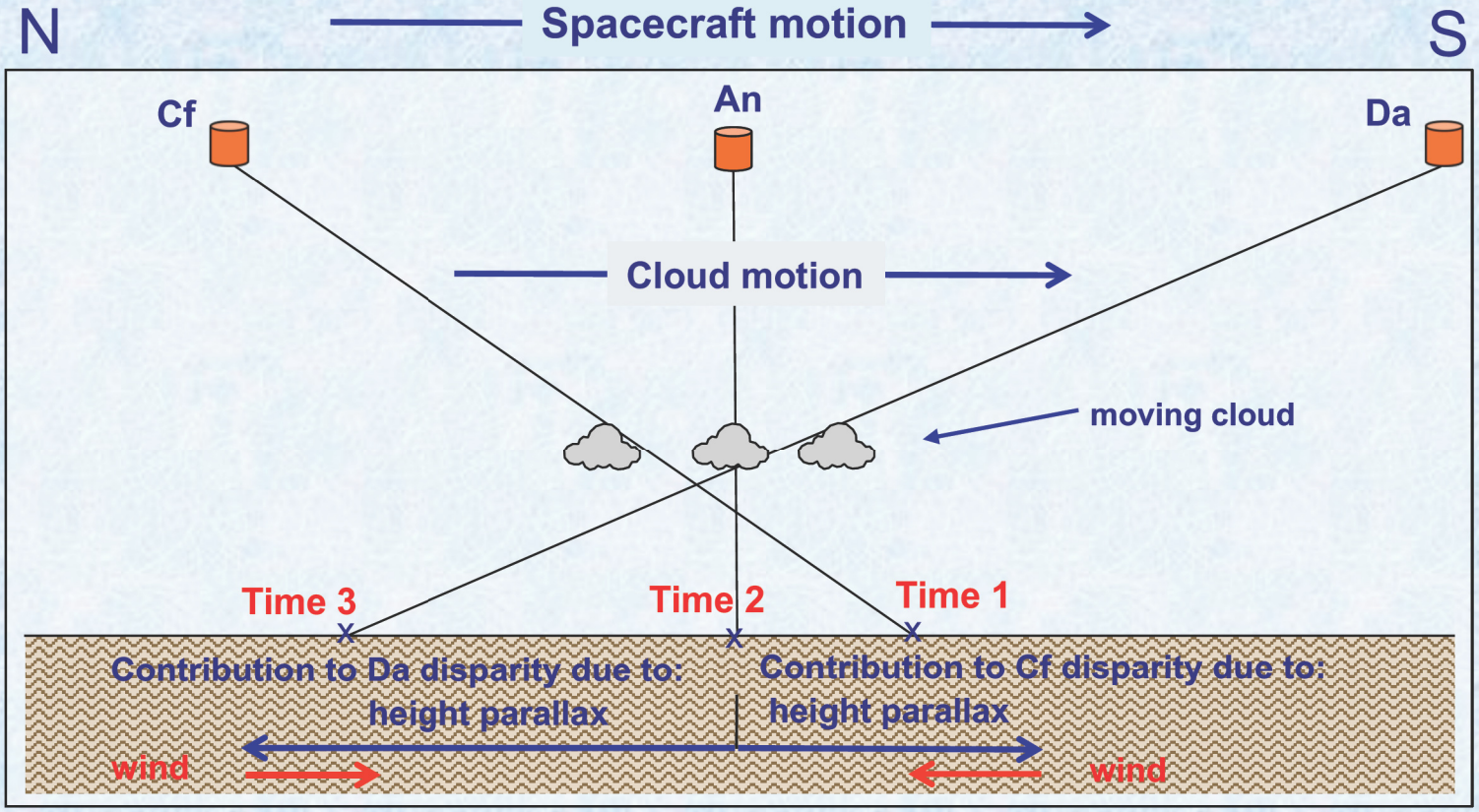


Cloud motion in direction opposite spacecraft motion

Disparity - 2

If entire disparity is attributed to height parallax (zero-wind height), then:

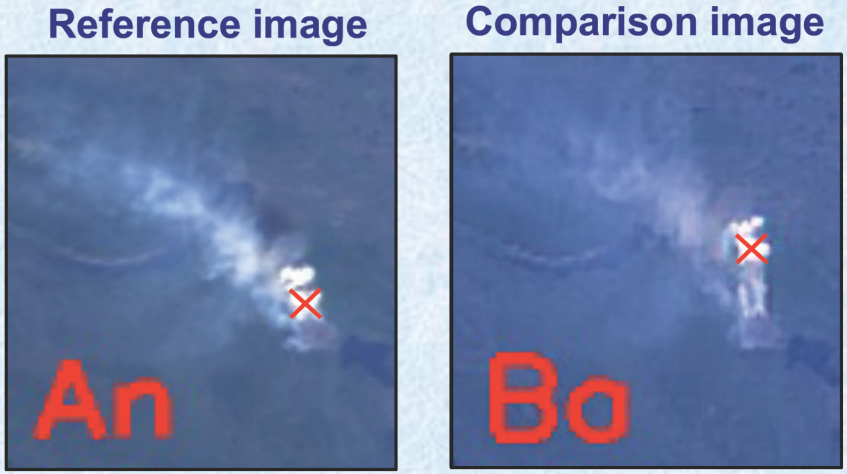
- **For cloud and spacecraft motion in same direction, height estimate is too low**
- **For cloud and spacecraft motion in opposite directions, height estimate is too high**



Cloud motion in same direction as spacecraft motion

Image Matching - 1

Objective: To find a feature in the image from a non-nadir camera that corresponds to a feature in the image from the An camera and to measure its disparity.



Alaska fire with small pyrocumulus clouds showing effect of parallax (plus motion due to wind?)

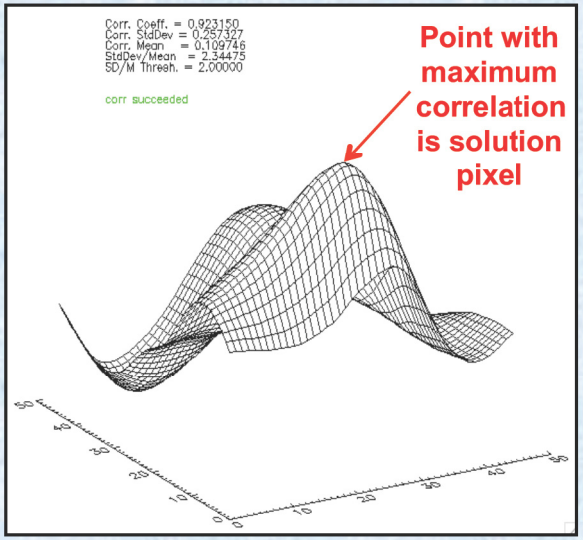
- In MINX, the An camera always acts as the reference image
- Six other cameras provide comparison images
- Image matching finds disparities between the target pixel location in reference image and the corresponding pixel location in the comparison image
- Disparity has SOM across-track and along-track components
- It can be applied to features on the earth's surface or above the surface
- MINX uses the correlation coefficient (CC) for assessing the quality of a match
- Image-matching will fail if the images lack texture or distinctive features

Image Matching - 2

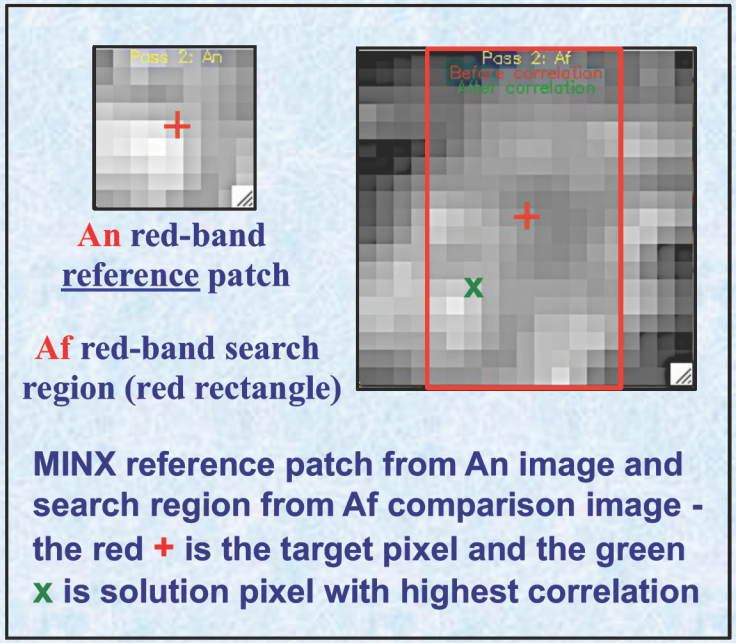
Correlation Coefficient: $r_{xy} = \dfrac{\sum (x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y}$

Where:

r_{xy} = correlation coefficient
x_i = BRF values at pixels in reference patch
$\bar{x}$ = mean value of the BRFs in reference patch
y_i = BRF values at pixels in comparison patch
$\bar{y}$ = mean value of the BRFs in comparison patch
n = number of pixels in reference patch
s_x = standard dev. of BRF values in reference patch
s_y = standard dev. of BRF values in comparison patch



Correlation matrix interpolated to obtain sub-pixel resolution



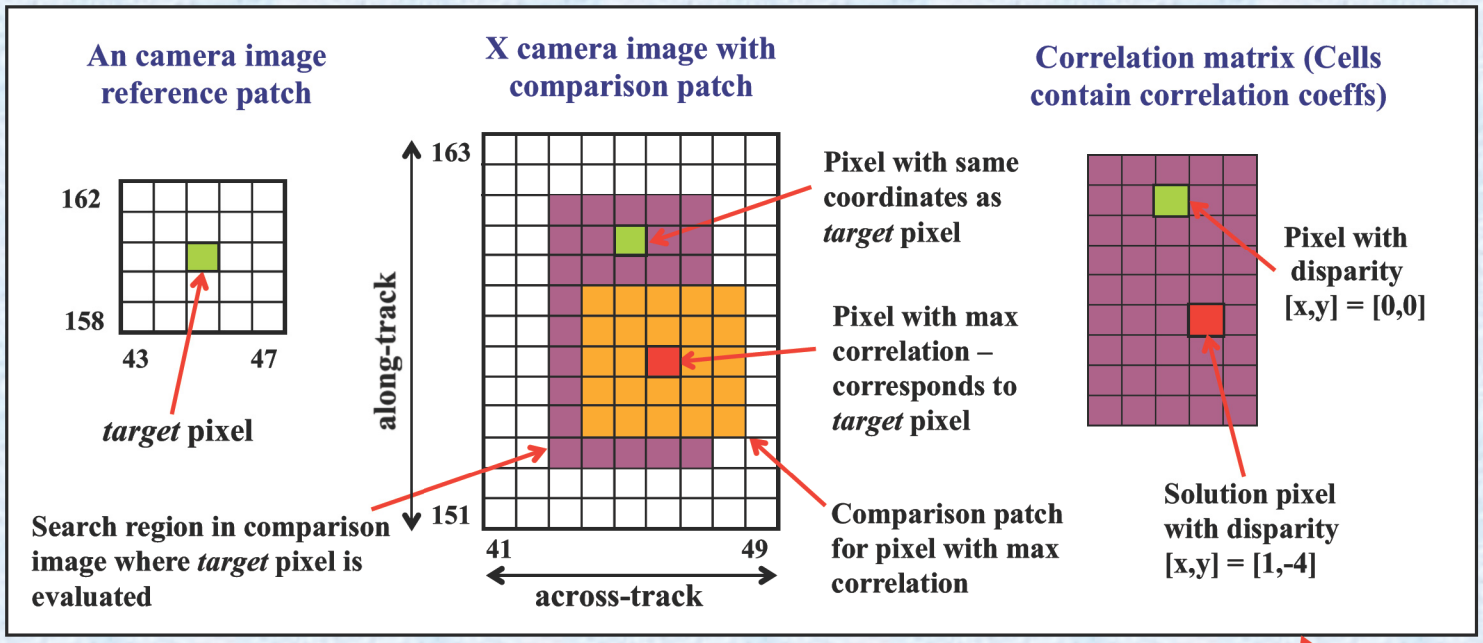
An red-band reference patch

Af red-band search region (red rectangle)

MINX reference patch from An image and search region from Af comparison image - the red + is the target pixel and the green x is solution pixel with highest correlation

- Correlation finds match to nearest pixel
- To increase precision, fit a bi-cubic surface to the correlation matrix around the solution pixel and interpolate to derive a finer grid
- Find the fine grid point with the largest CC - this gives fractional (sub-pixel) disparities

Image Matching - 3



① Center the reference patch over the upper-left most pixel in the comparison image's search region

② Calculate correlation coefficient using BRFs for the overlapping pixels and place results into its corresponding location in correlation matrix

③ Slide the reference patch to next pixel in search region and compute CC again –repeat for all pixels in the search region

④ The pixel in the comparison image with highest CC is the match

Violet area is the search region where corresponding pixel is known to be based on computed maximum height and wind speed

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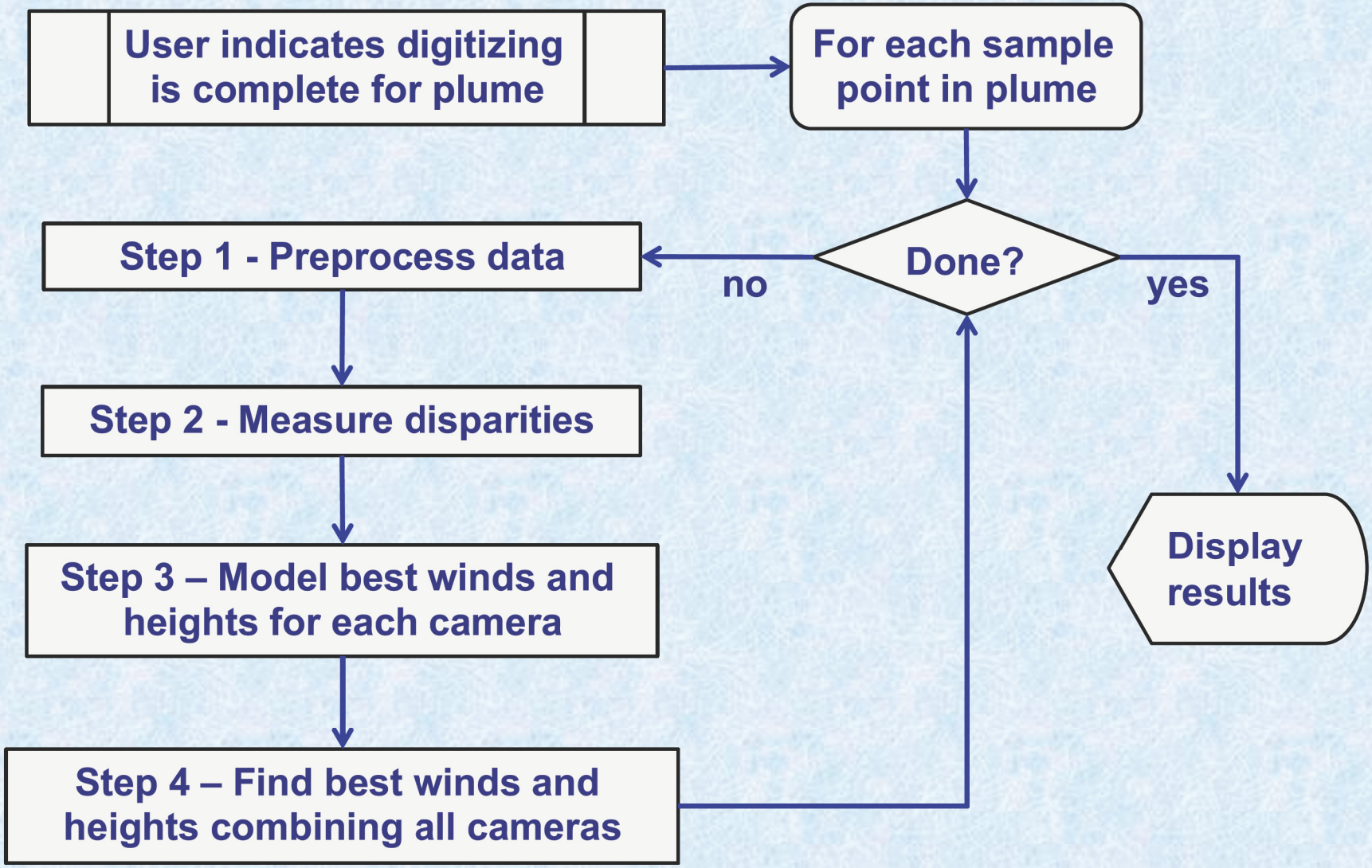
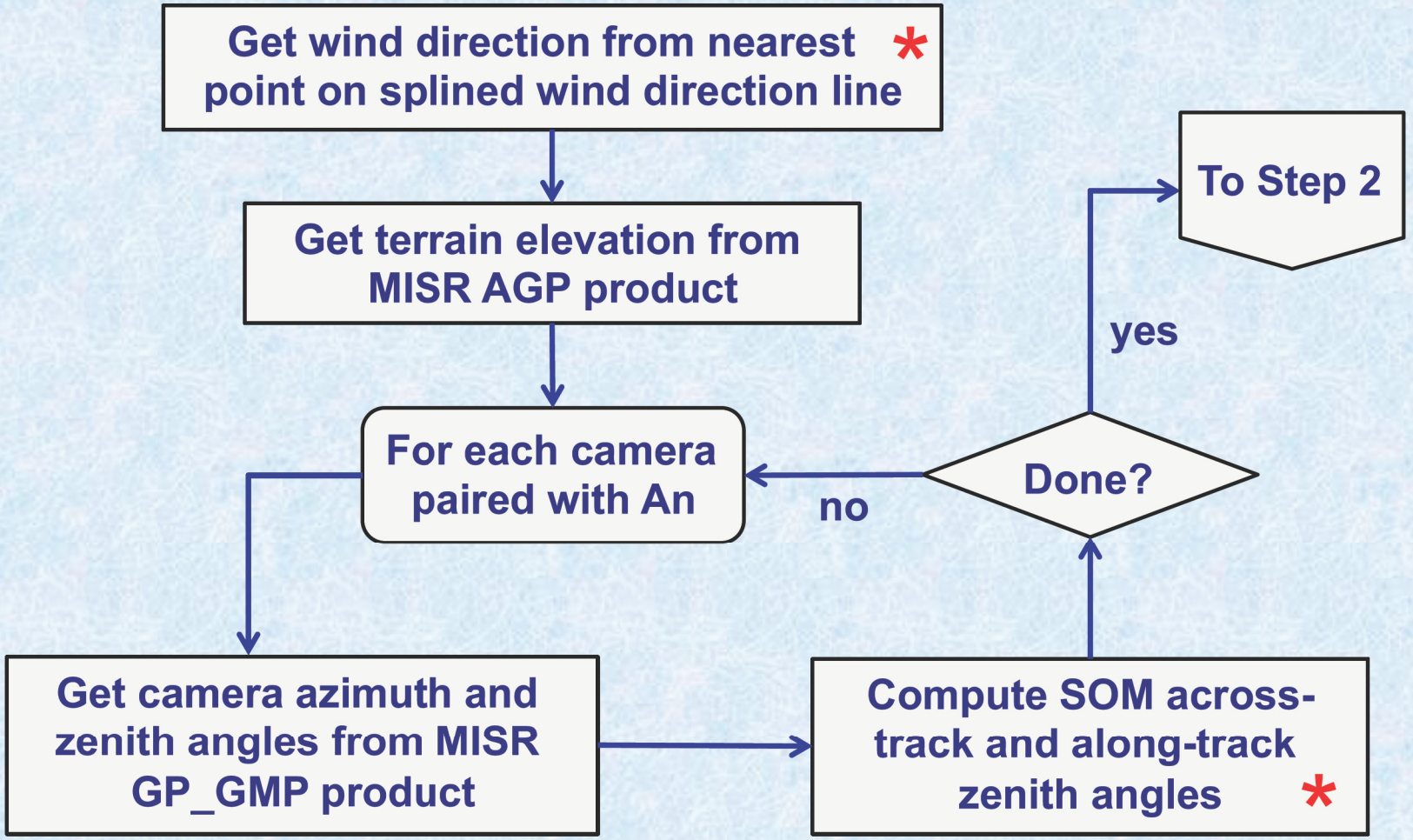
MINX Top Level Algorithm

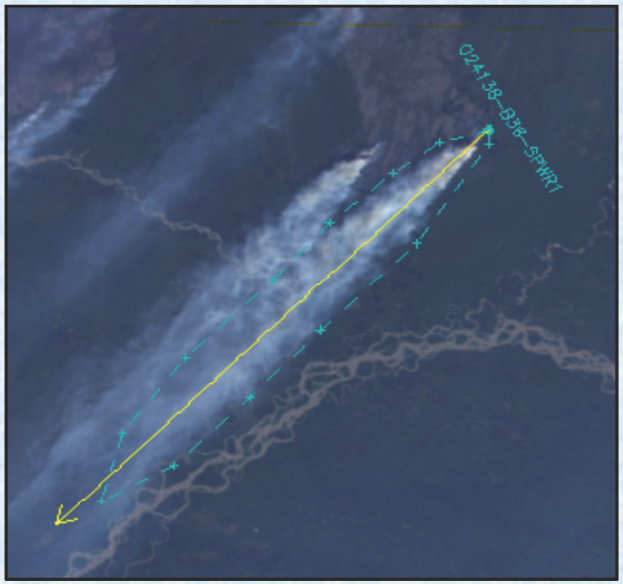


Step 1 - Preprocess Data

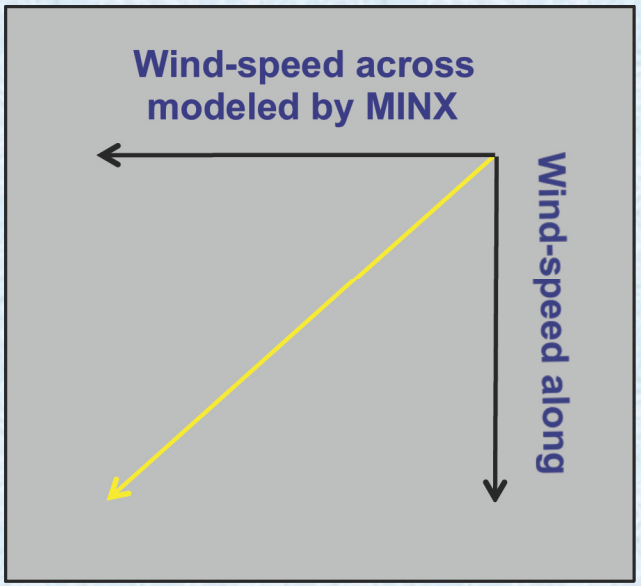


Get Wind Direction

- The height/wind retrieval problem has 3 unknowns :
  height, wind-speed across-track and wind-speed along-track
- User inputs a (wind) direction of motion during digitizing
- If either the across-track or the along-track wind speed is known, the other component can be computed using the wind direction
- Thus the retrieval problem simplifies to 2 unknowns



Digitized plume showing
"wind direction" line in yellow



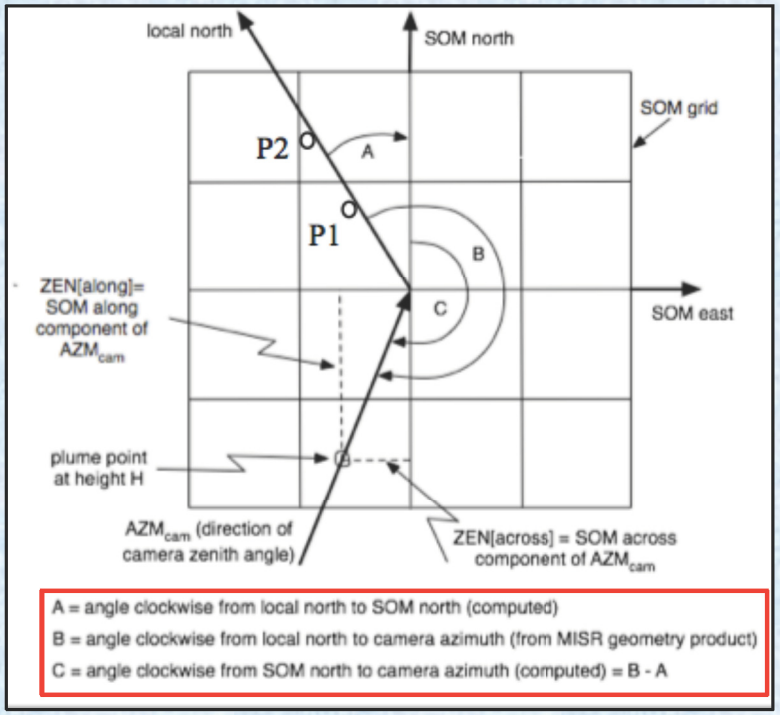
Wind-speed along-track is easily computed from wind-speed across-track plus wind direction

Compute Across and Along-Track Zenith Angles

Objective: To convert camera azimuth angle and camera zenith angle into 2 orthogonal components of zenith angle in the SOM across-track and along-track directions. This allows us to compute the 2 components of disparity independently.

① Create a closely spaced pair of points P1 = [lat1, long] and P2 = [lat2, long] on the same geographic meridian in the region of interest, and project each to SOM coordinates

② Find distances (dx_{north}, dy_{north}) along the SOM_{north} and SOM_{east} axes between the points



③ Compute the angle, *A*, clockwise from local north to SOM_{north}: $A = ATAN(dx_{north}, dy_{north})$

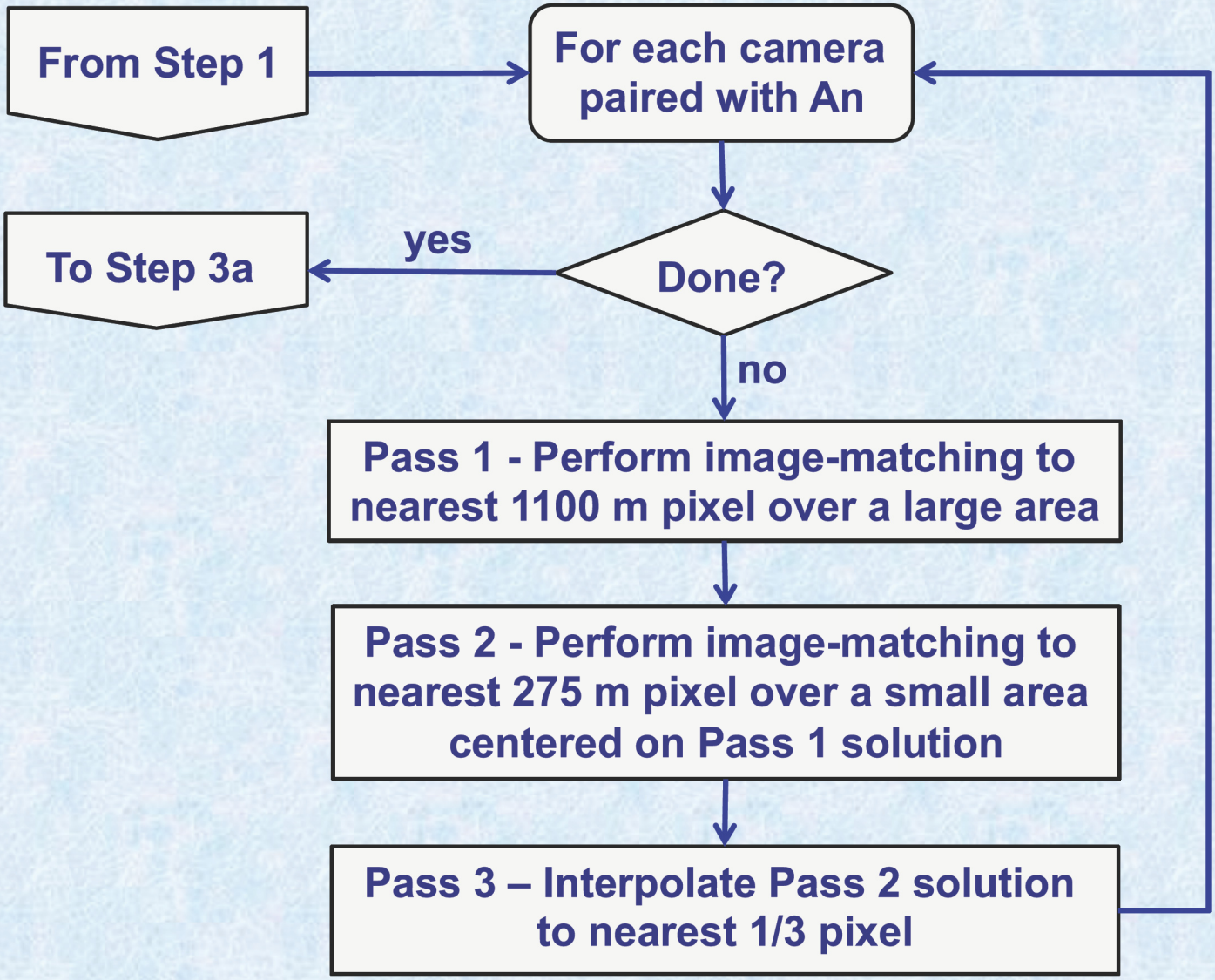
④ Compute the angle, C, clockwise from SOM_{north} to the azimuth direction of the camera (AZM_{cam}) to give the SOM-relative azimuth angle of the camera (AZM_{som}): $C = B - A$

⑤ Decompose the camera zenith angle (ZEN_{cam}) into across-track and along-track components to derive the SOM zenith angles (ZEN_{som}):

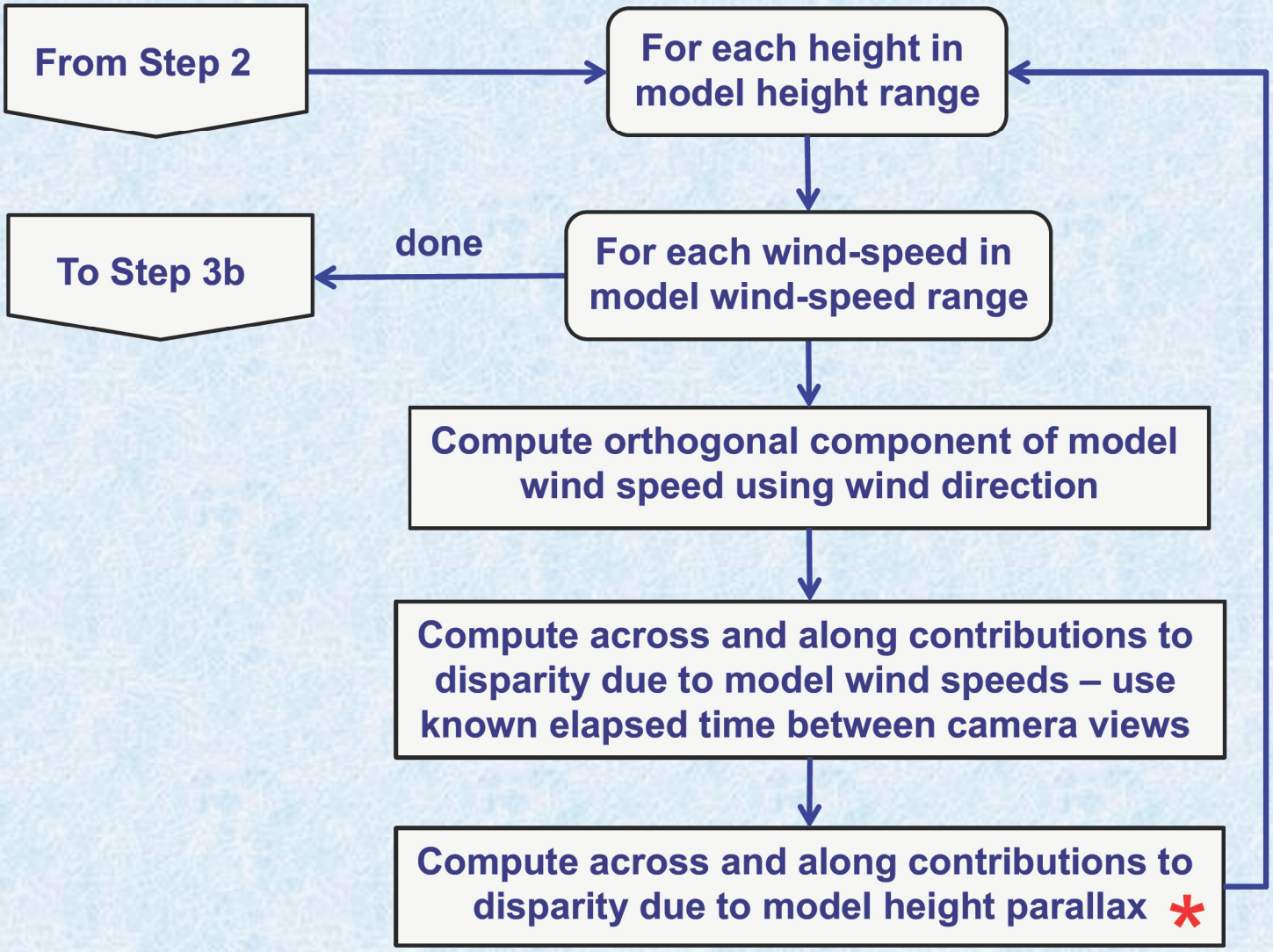
$$ZEN_{SOM}[across] = ZEN_{CAM} * SIN(AZM_{SOM})$$

$$ZEN_{SOM}[along] = ZEN_{CAM} * COS(AZM_{SOM})$$

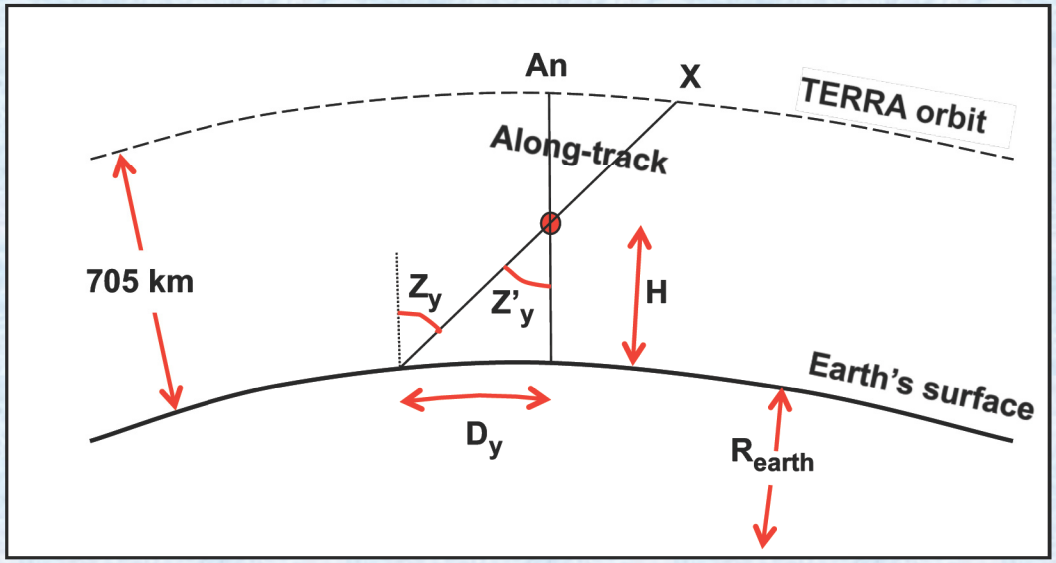
Step 2 – Measure Disparities



Step 3a – Forward Model Winds and Heights for Each Matched Camera



Compute Across and Along Contributions to Disparity due to Parallax



Earth geometry used in modeling along-track component of disparities due to height parallax

Forward modeling equation to compute disparity (D_y) for one camera in along-track direction:

$$D_y = \left(ASIN\left(\frac{H+R_{earth}}{R_{earth}} * SIN(Z'_y) \right) - Z'_y \right) * C_{earth}$$

The same equation is used to compute disparities in the across-track direction.

Where:

D_y = disparity in SOM y direction

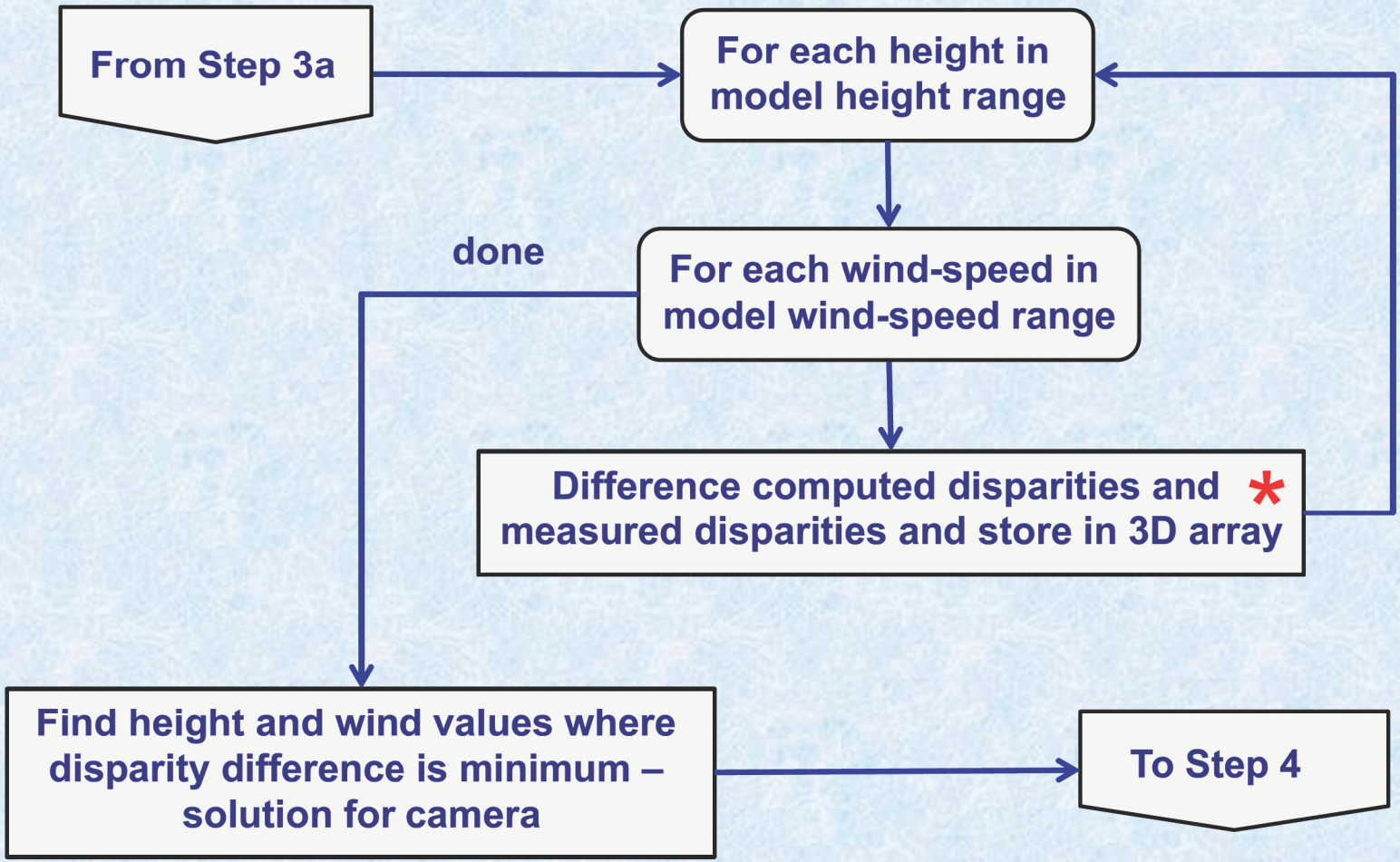
H = height of aerosol pixel above ellipsoid

R_{earth} = radius of earth = 6371 km

C_{earth} = circumference of earth = 40,030 km

Z'_y = zenith angle component in SOM_{along} direction (Z'_y closely approximates camera zenith angle Z_y)

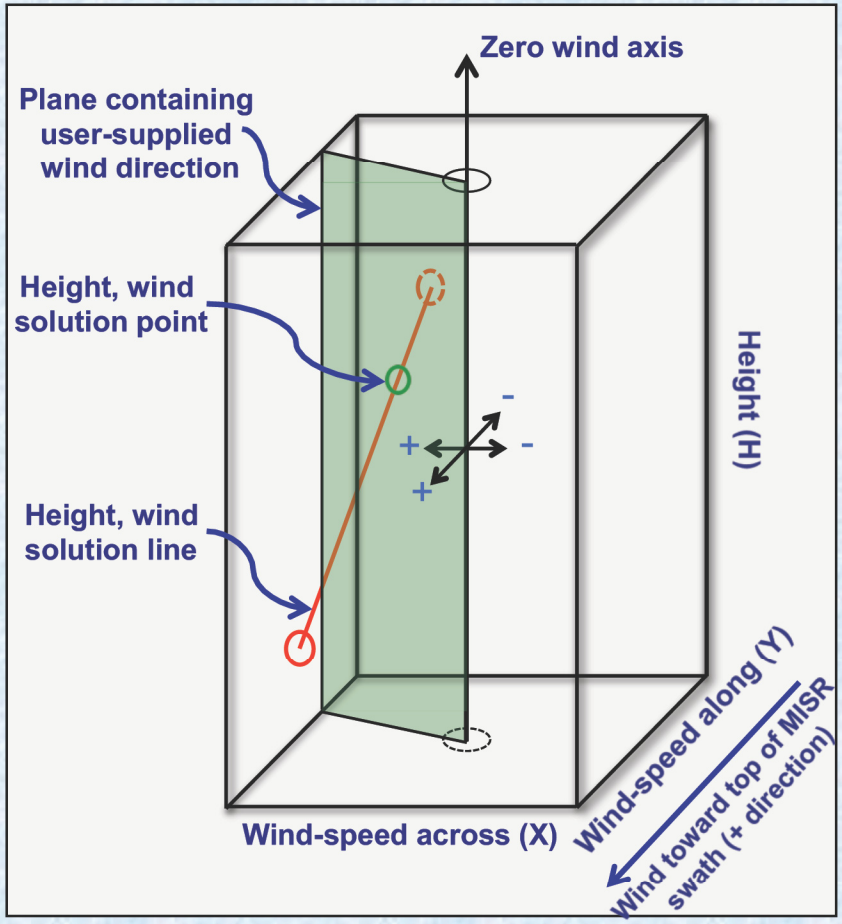
Step 3b – Find Best Height and Winds for Each Matched Camera



3D Data Cube of Disparity Differences

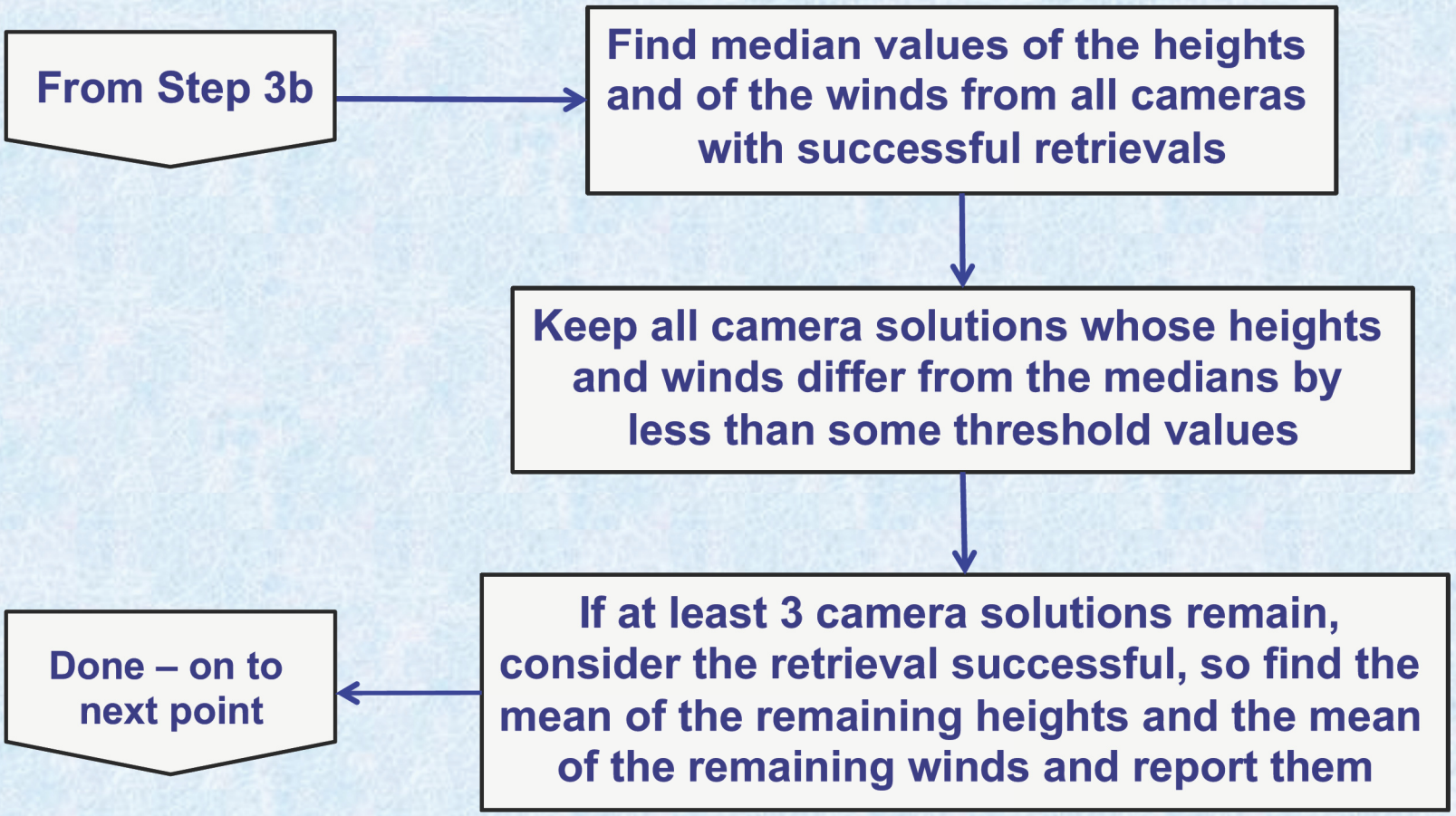
- Each node in the data array is indexed by model parameters X (wind-speed across), Y (wind-speed along) and H (height)
- Each node contains a disparity difference: $D_{total} = D_{measured} - D_{modeled}$
- Best height/wind solutions exist wherever $D_{total} = 0$; this is true for all points on a sloping line parallel to the wind-speed along axis
- The intersection of this line with a plane containing the user-supplied wind direction is the solution

If wind direction is known, modeling needs to be done only in the plane containing the wind direction - 3 unknowns reduce to 2 and a camera pair rather than a camera triplet is able to provide a unique solution



3D data array for solution of winds and height for one camera at one data point

Step 4 – Find Best Height and Winds Combining all Successful Cameras



MISR vs. MINX Stereo Height Algorithms

Feature	MISR Standard Stereo Product	MINX
Level 1 imagery	Ellipsoid-projected	Terrain-projected
Matcher cost func	Mean of normalized differences	Pearson's correlation coefficient
Order of solution	Winds retrieved first, heights later	Winds and heights retrieved simultaneously
Cameras used	An / Bx / Dx triplets for wind Af / An / Aa triplets for height	Cf, Bf, Af, Aa, Ba, Ca, each paired with An for height and wind
Wind retrieval dependency	Depends on earth curvature viewed by D cameras and applicable to any feature above the terrain	Depends on knowledge of wind direction and generally applicable only to plumes or where wind direction is known
Wind resolution	Wind retrievals averaged over 70.4 km and applied to heights at 1.1 km	Heights and winds retrieved simultaneously at 1.1 km resolution
Number of unknowns	3: wind speed across-track, wind speed along-track and height	2: one wind speed plus height; the other wind speed is derived from user-supplied wind direction
Methodology	Finds unique inverse solution using 1 set of camera triplets (2 sets for wind)	Uses forward modeling that averages results of up to 8 camera pairs

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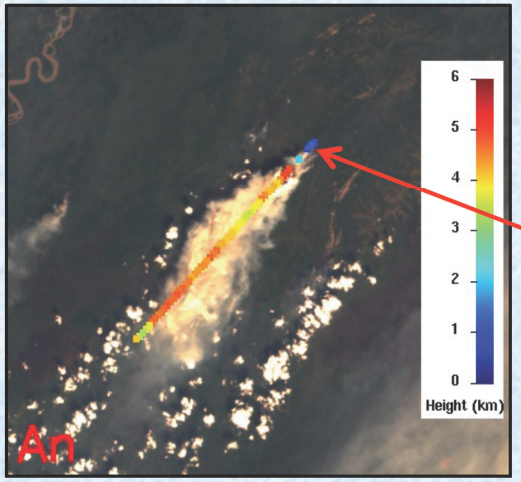
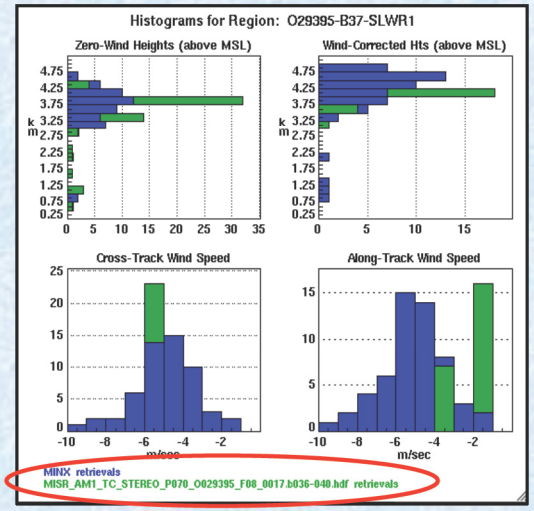
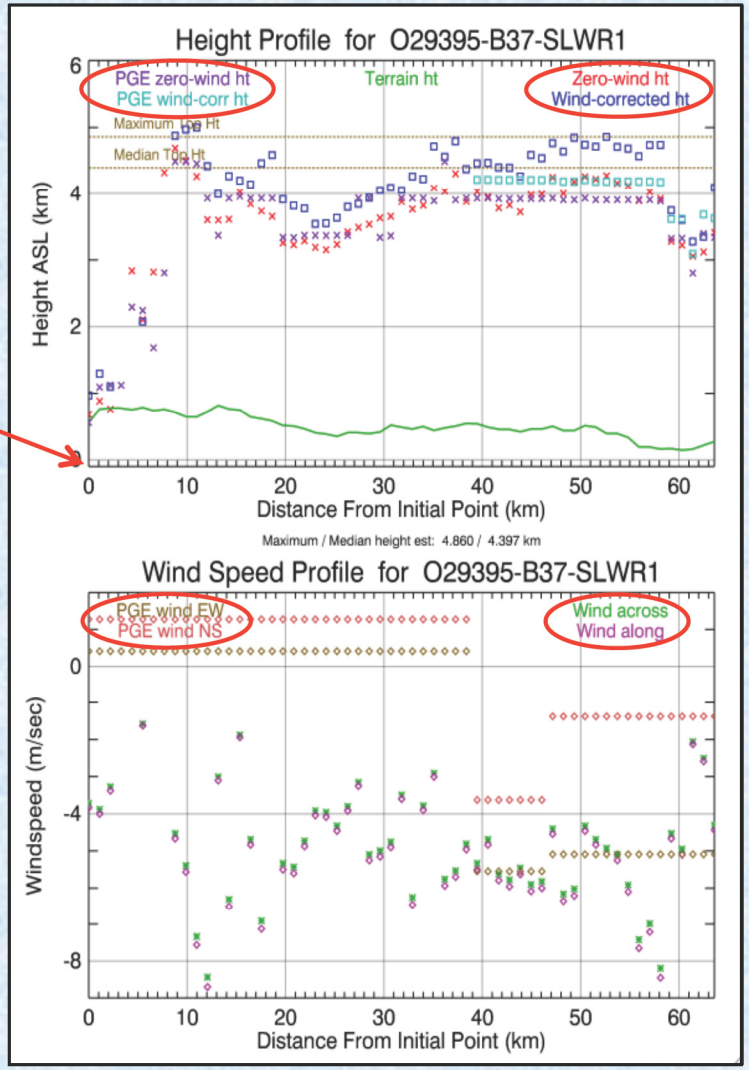
MINX Height Retrieval Comparison - 1



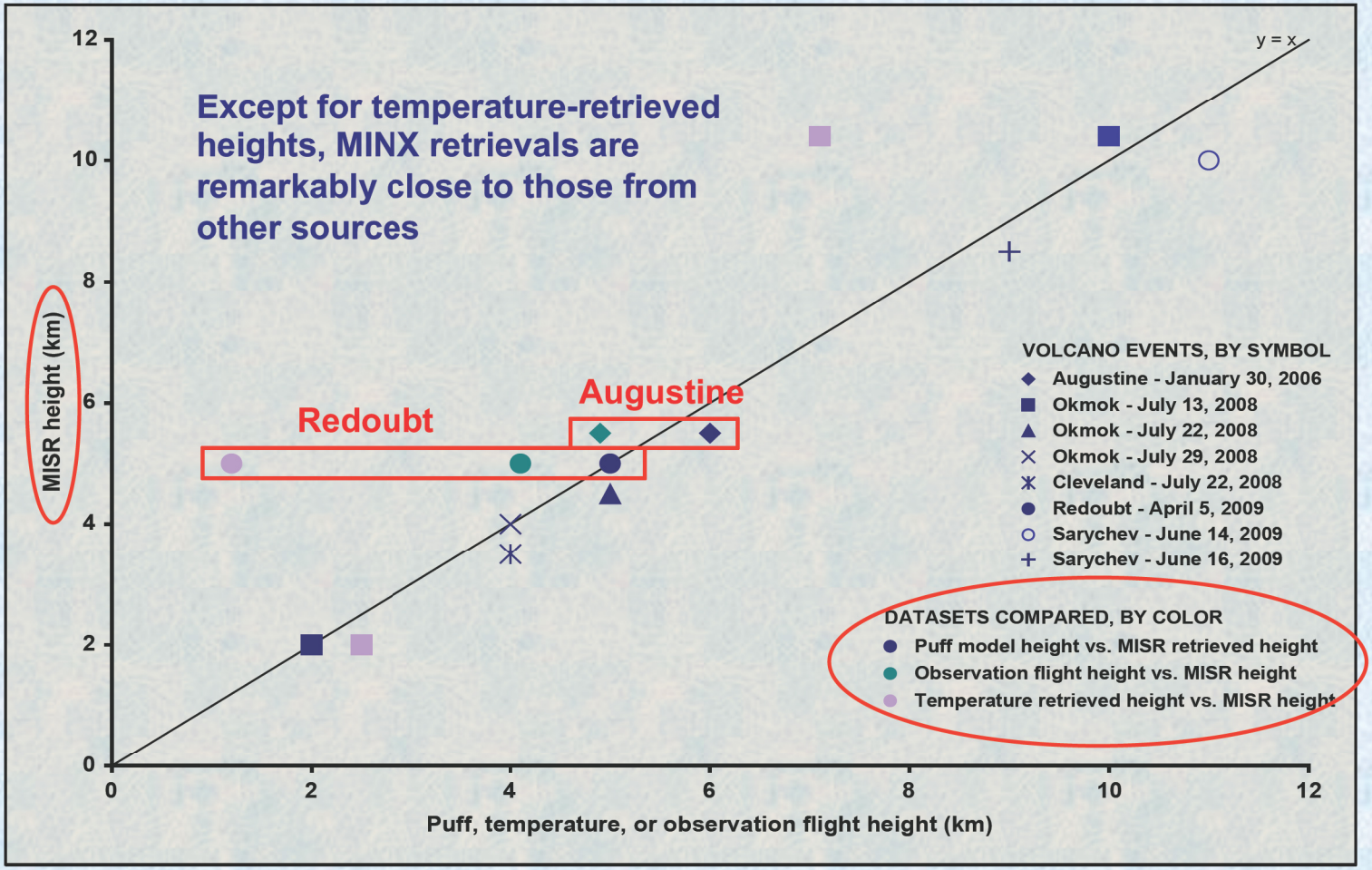
- MINX and MISR zero-wind and wind-corrected heights are similar
- MISR heights and winds are "quantized" due to matching at whole pixel level
- MISR winds are constant over large distances due to 70.4 km resolution retrieval
- Across-track winds are more similar than along-track winds
- A new version of the MISR stereo product produces significantly improved results





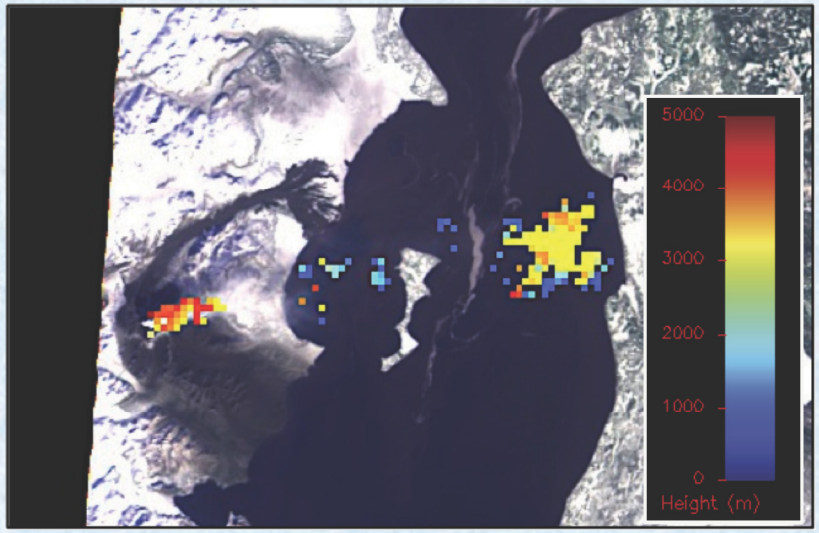
MINX Height Retrieval Comparison - 2

MINX plume heights for 8 Ring of Fire volcanic eruptions compared with heights from other sources

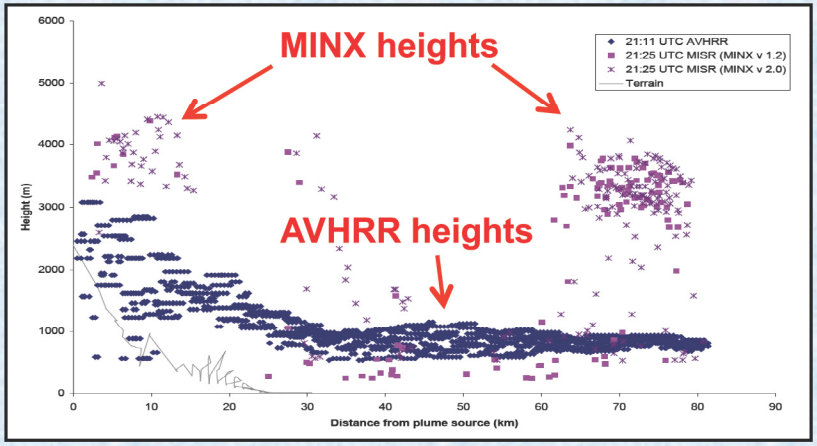


Courtesy of Angela Ekstrand, Alaska Volcano Observatory

Redoubt Eruption – Alaska – April 5, 2009



AVHRR retrieves heights near the water surface when the ash plume is thin

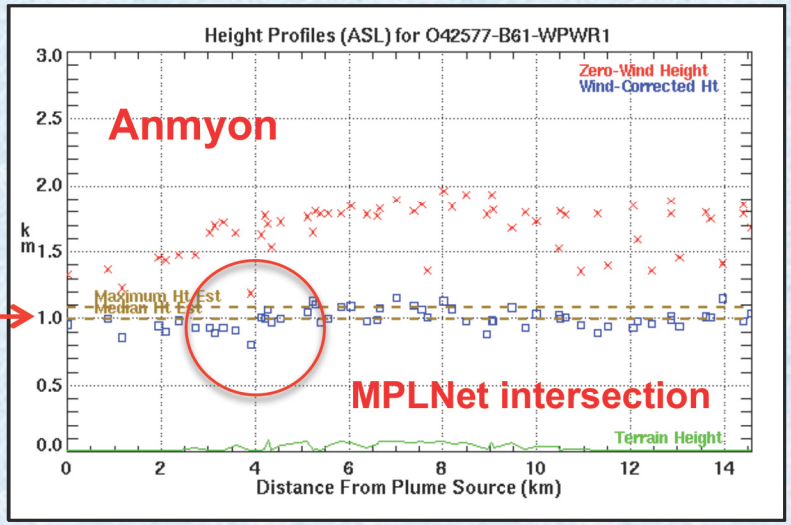


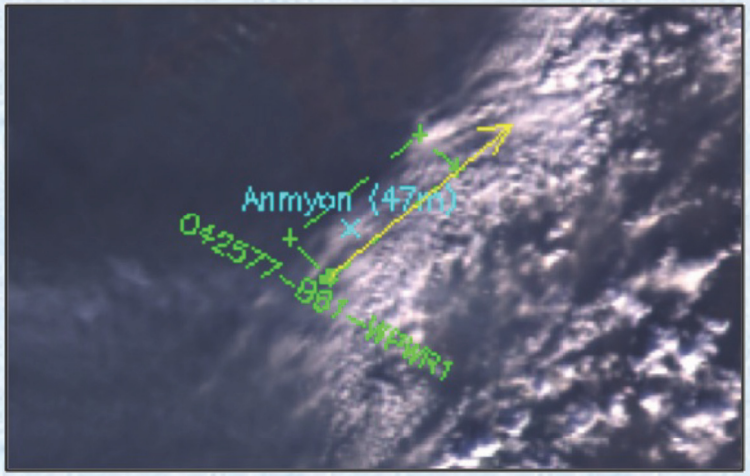
Images and analysis courtesy of Angela Ekstrand et al, AGU 2010

MINX Height Retrieval Comparison - 3

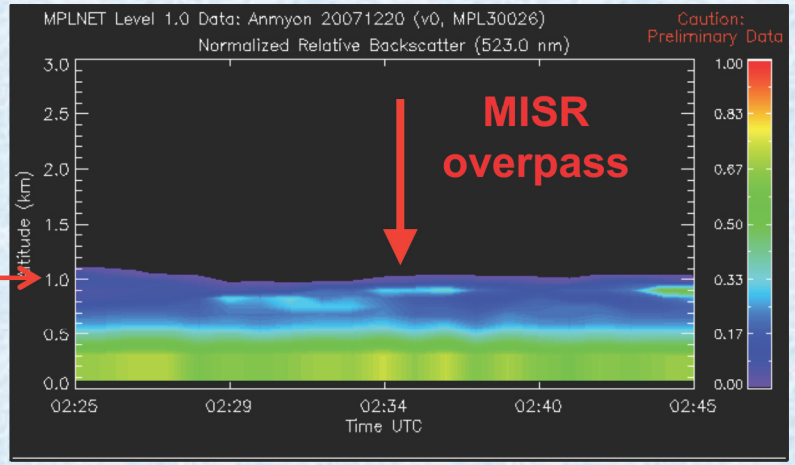
Collocation of micropulse lidar and MISR data at Anmyon on the coast of South Korea

by Ben Dunst, UCLA
and Mike Garay, JPL

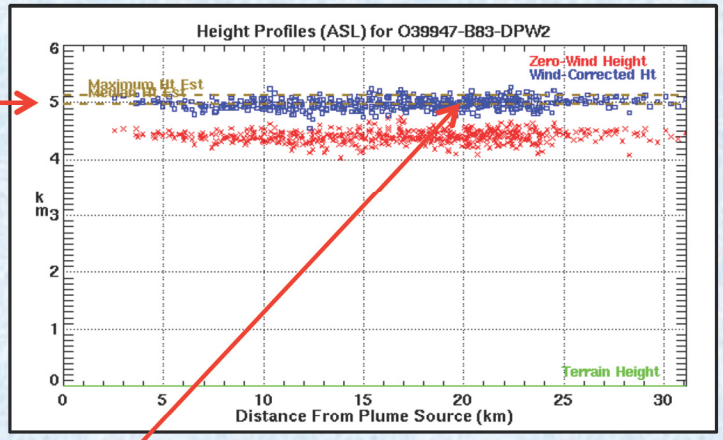


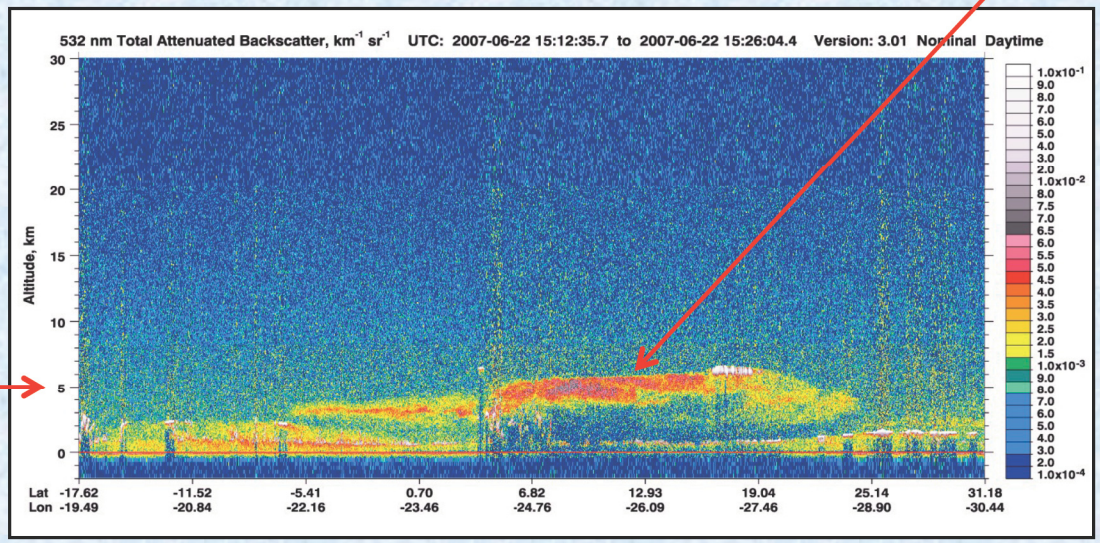


Wind direction for MINX retrieval derived from meteorological data



MINX Height Retrieval Comparison - 4





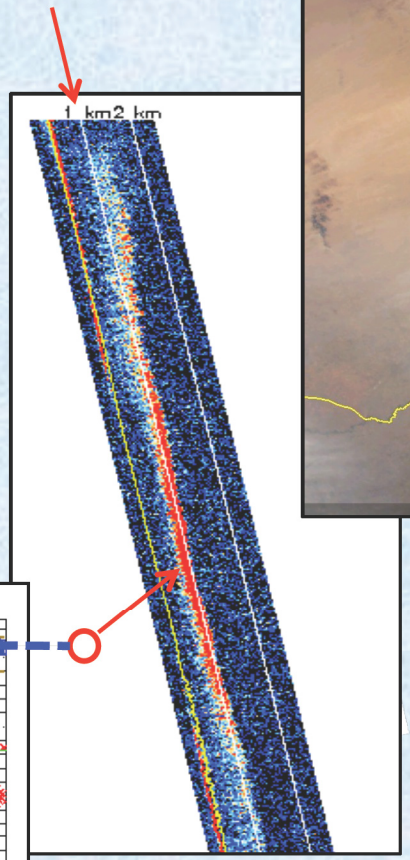
Dust over Atlantic Ocean off West Africa seen by Calipso lidar and MISR

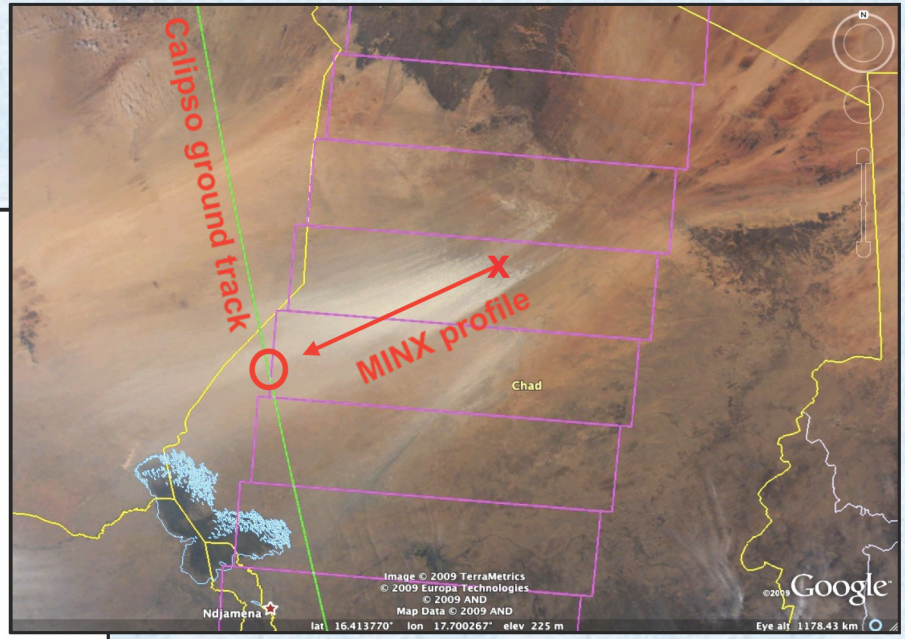
by Olga Kalashnikova and Mark Chodas, JPL

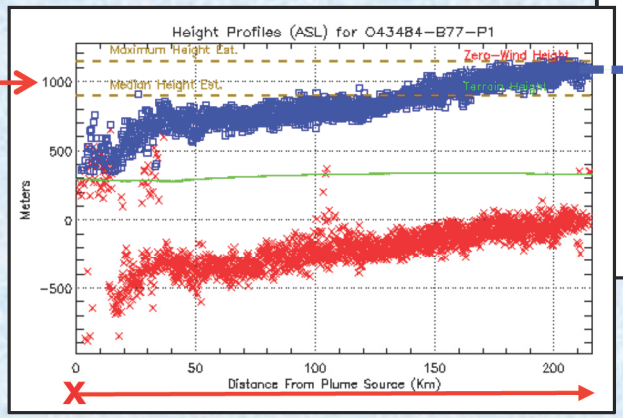
MINX Height Retrieval Comparison - 5

Dust over Bodele Depression, Chad seen by Calipso lidar and MISR

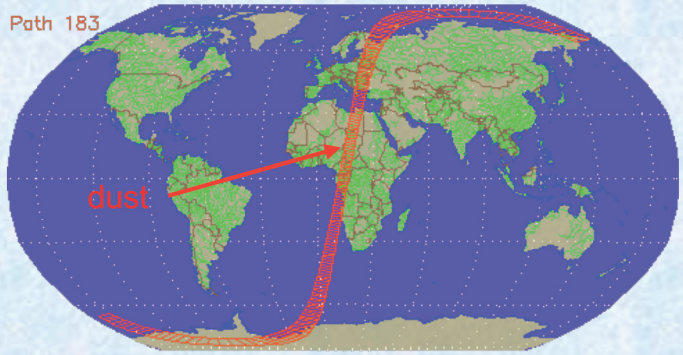
by Mike Garay, JPL







Path 183



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Digitizing Procedure Overview

① Load Level 1 radiance images (session 2)

② Adjust image color and brightness (session 2)

③ Assess and correct camera co-registration errors

④ Load MODIS fire pixels if appropriate (session 4)

⑤ Study feature geometry and scene context to determine:

- Outline of feature to digitize
- Wind direction to digitize
- Retrieval parameters (session 4)

⑥ Digitize feature

- Digitize outline and wind direction
- Select AGP and GP_GMP product files to load when prompted (required)
- Select other MISR product files when prompted (optional)

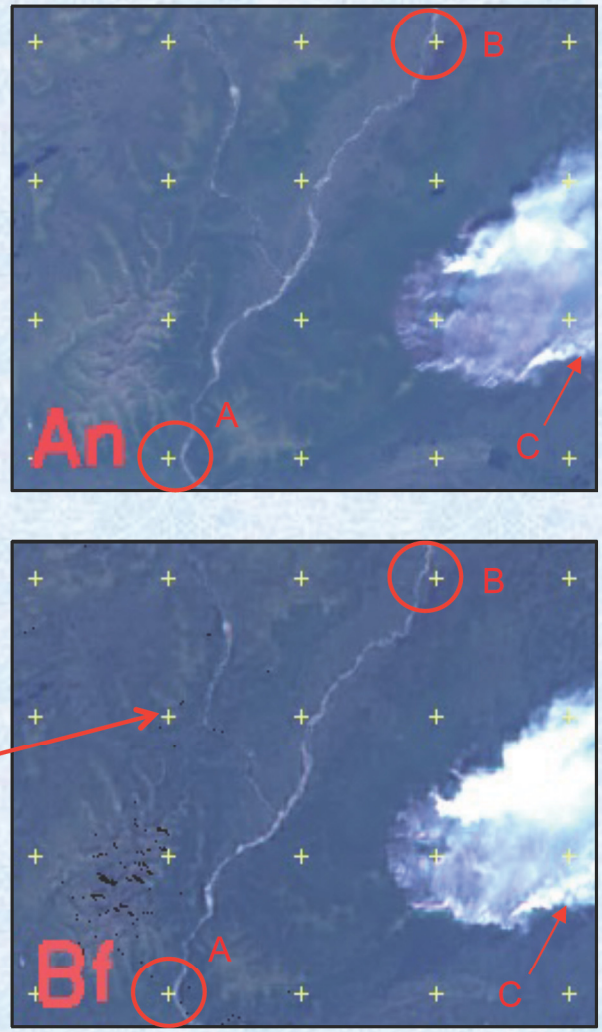
⑦ Evaluate digitizing results

- Study height/wind plots and color overlays
- Delete digitized feature if not satisfactory
- Redigitize with new parameters
- more in session 4

Camera Registration Correction - 1

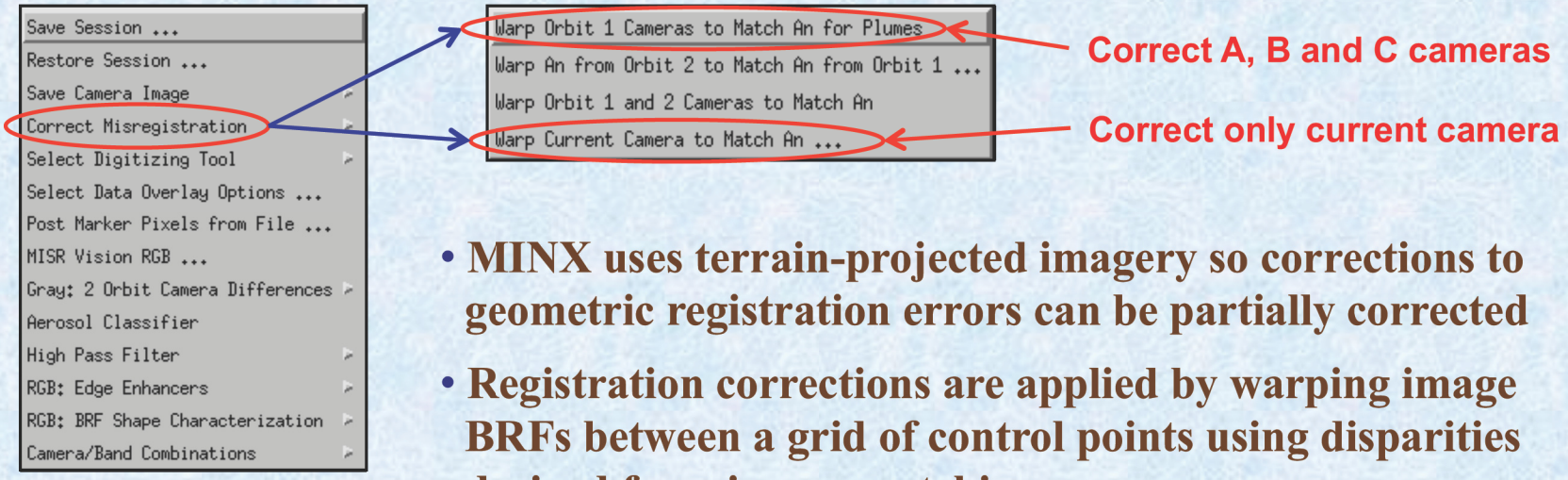
Objective: To improve stereo height retrieval accuracy by reducing errors in camera-to-camera geometric registration before image matching is performed.

- 1 pixel registration error can lead to a height error of ~ 550 m for Af/Aa cams and ~ 150 m for Cf/Ca
- Mean co-registration error of MISR data < 1 pixel
- Some orbits misregistered by more than 2 pixels
- Co-registration errors are evaluated on a regular grid of control points using image-matching with An as reference camera
- To assess misregistration:
  - ① Turn on MINX "Fixed Grid" (yellow + symbols)
  - ② Animate cameras
  - ③ Study distinctive terrain features near yellow grid points (circles A and B) – Bf image is displaced left relative to An by 3 pixels
  - ④ Do not compare features in clouds or plumes (C) which are expected to "misregister"



Bf camera is mis-registered by -3 across-track pixels relative to An

Camera Registration Correction - 2



- **MINX uses terrain-projected imagery so corrections to geometric registration errors can be partially corrected**
- **Registration corrections are applied by warping image BRFs between a grid of control points using disparities derived from image-matching**

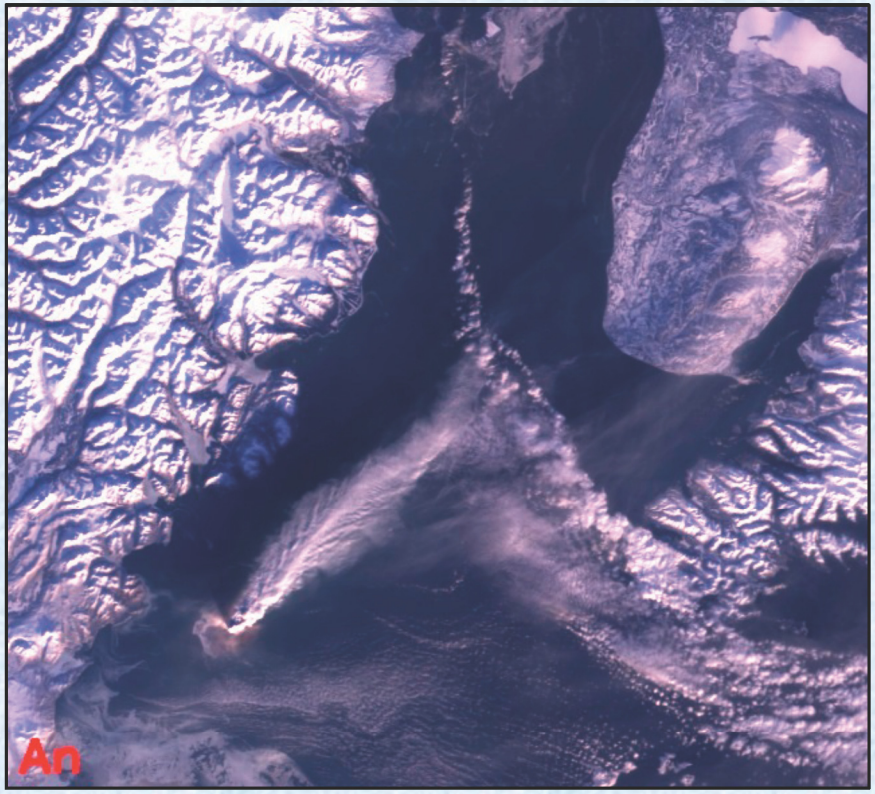
- **Corrections are conservative - rapid variations in disparities are ignored**
- **To <u>correct</u> misregistration:**
  1. **If only one camera requires correction, select that camera in the image window, then select "Correct Misregistration" from the MINX Analysis menu, finally select "Warp Current Camera to Match An"**
  2. **If more than one camera requires correction, select the An camera in the image window, then select "Correct Misregistration" from the MINX Analysis menu, finally select "Warp Orbit 1 Cameras to Match An for Plumes" – A, B, C cameras will be processed**
- **Another source of co-registration error is MISR's digital elevation model (DEM) – these errors vary more rapidly and cannot be corrected**

Study 3D Geometry and Scene Context - 1

Objective: To isolate the aerosol feature from its surroundings and to understand its dynamics so a reasonable boundary and wind direction can be assigned.

- **Observations (see next slide):**
  - **On Da and Ca cameras, a vertical column of ash marks the origin of plume (at the volcanic vent)**
  - **Ash from the volcano is wind-blown toward the upper right in image**
  - **Animating cameras gives the "illusion" of plume motion from bottom to top – effect of parallax**
  - **The plume intersects an upper-left to lower-right trending string of cloud**
  - **The plume is higher than the clouds since its parallax is greater**
  - **The plume is bifurcated with "ribs" on either side of central "spine"**

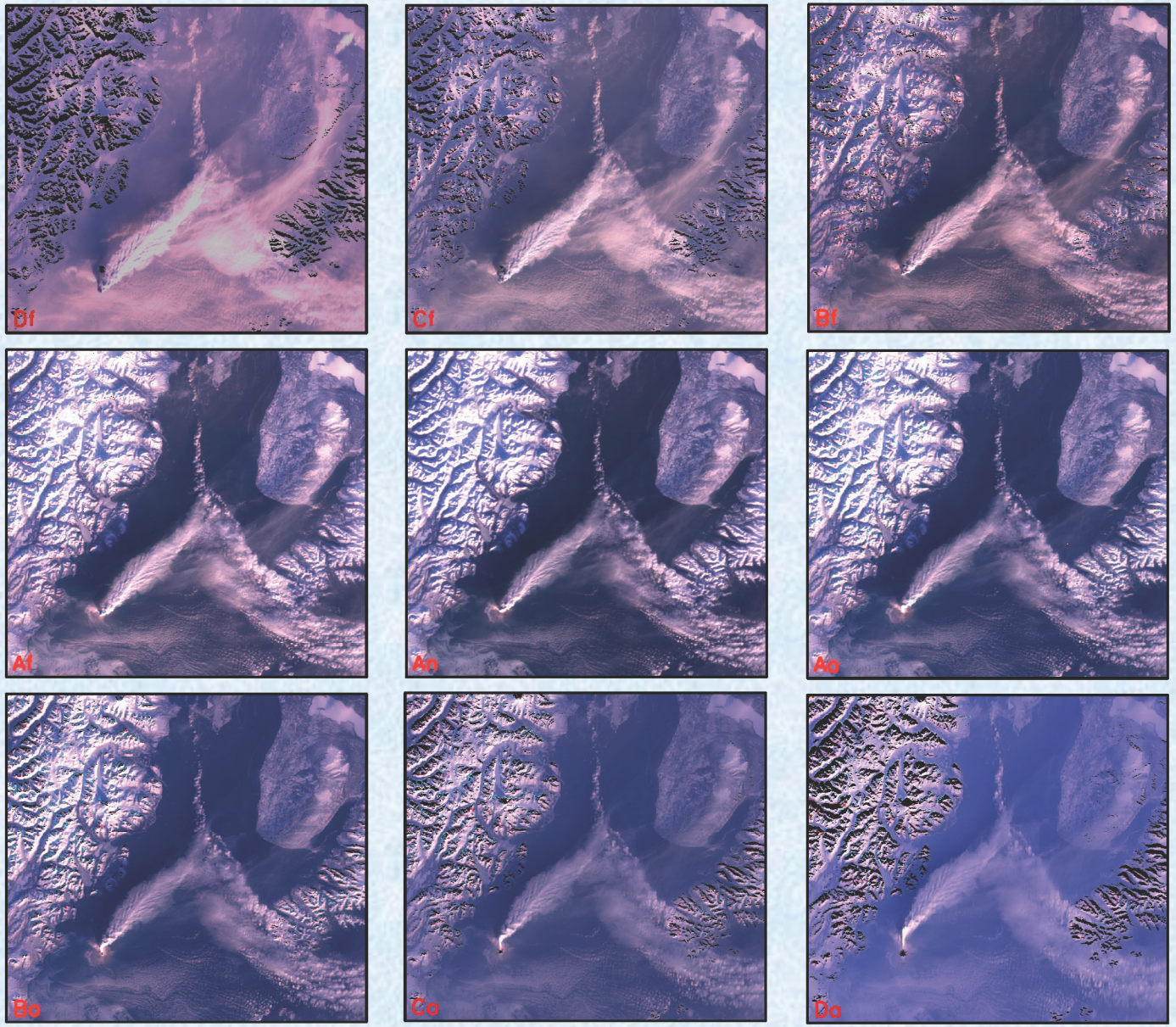
Terrain-projected BRFs



Augustine Volcanic Eruption, January 30, 2006

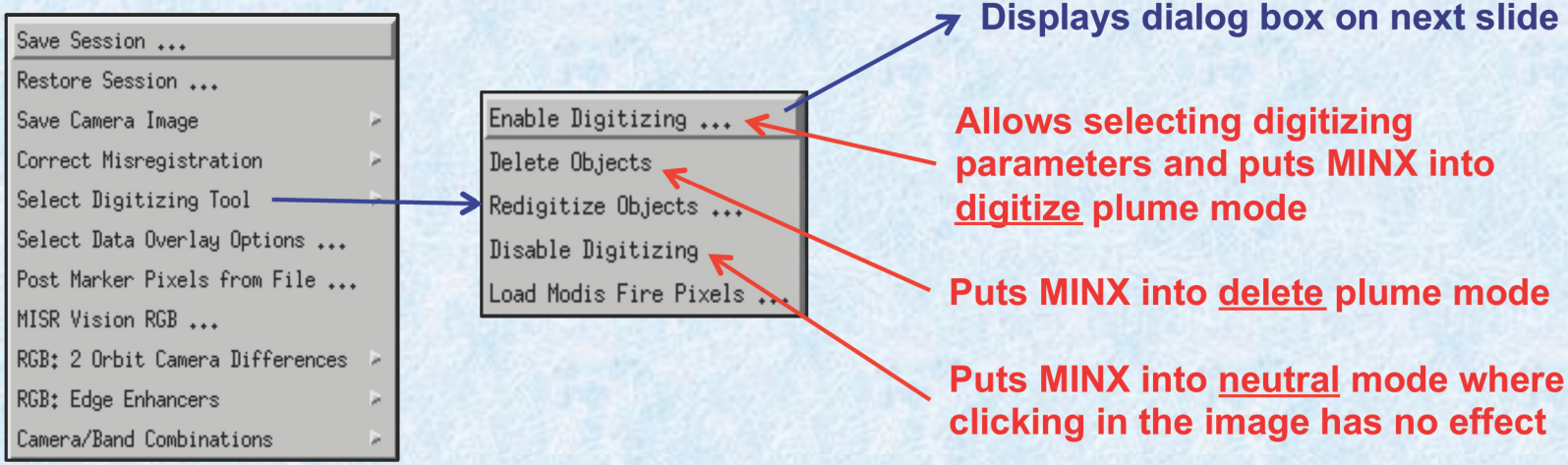
77 km

Study 3D Geometry and Scene Context - 2



Digitize Plumes - 1

Objective: To define a plume boundary for the height retrieval code within which heights and winds will be retrieved and to provide a wind direction necessary for correcting the heights.



- MINX stores all regions (plumes and clouds) digitized for an orbit in a linked list
- Each region node contains pointers to linked lists of:
  - Points defining the boundary of the polygon
  - Points defining the wind direction line, if any
  - Points on a regular grid in the interior of polygon where heights will be retrieved

Digitize Plumes - 2

Selection determines the name of plume and the color of digitized polygon

If you have an IDL license, a 9-camera MPG or MP4 animation is saved – otherwise 9 JPEG images are saved

An image containing data from MISR standard Aerosol product is saved

Top-of-atmosphere albedos are computed and saved

You will be asked for a MISR standard Stereo product file, and those heights and winds will be added to profile plots

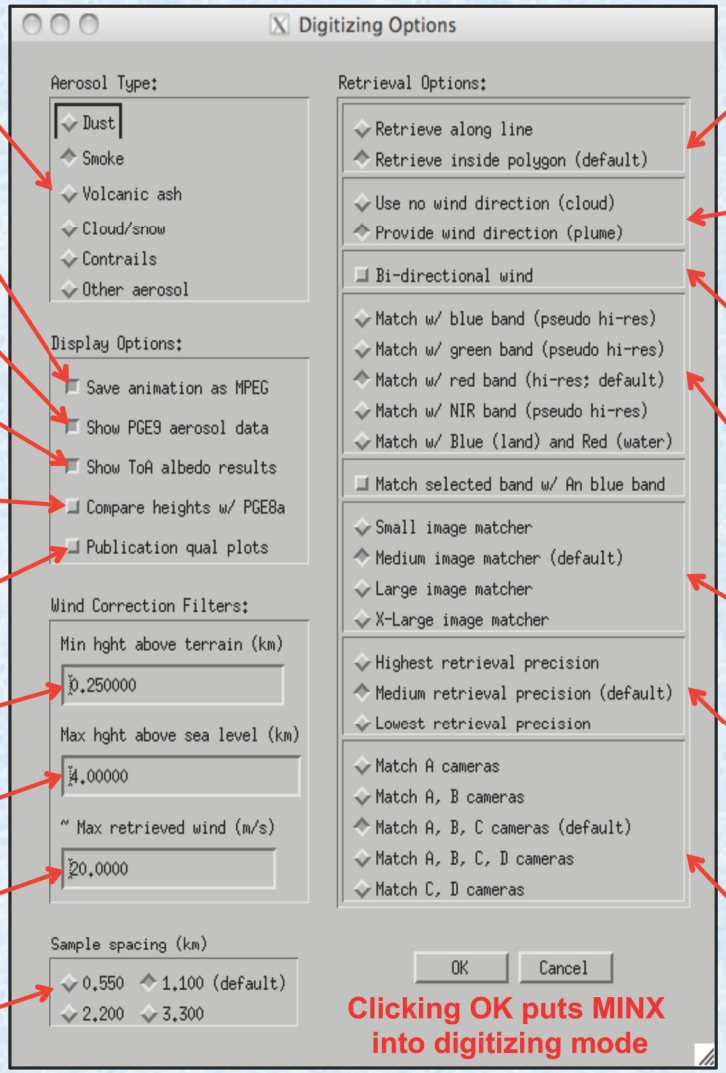
Profile plots will be drawn with higher resolution and fewer annotations and camera names are not written on images

No wind-corrected heights below this distance above terrain will be retrieved

No wind-corrected heights above this distance above sea level will be retrieved

No wind speeds above this value will be retrieved

Grid spacing between points in the plume polygon where retrievals are attempted



Clicking OK puts MINX into digitizing mode

Retrieve heights and winds either along a digitized line or inside a digitized polygon – along line requires using "wind direction"

Compute only zero-wind heights (cloud) or compute zero-wind heights plus winds and wind-corrected heights (plume) – no wind direction requires "Retrieve inside polygon"

Digitized wind directions as well as 180 degree opposite wind directions are used – e.g. across eye of hurricane

Select MISR band(s) to use in the image matching step – if plume extends over land and water, "Match w/ Blue and Red" helps

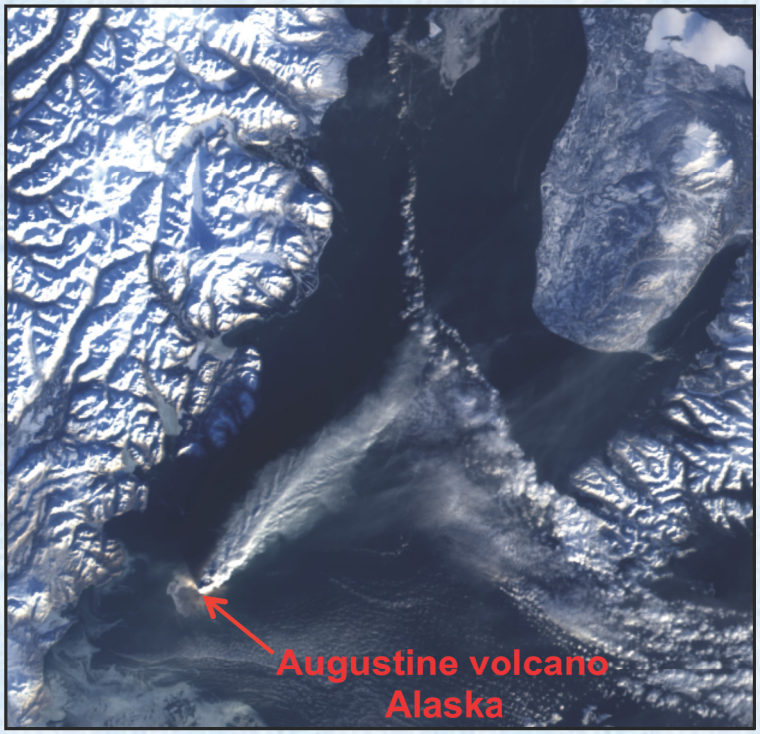
Select the size of the image matcher to use – larger is slower and smooths results but increases the number of retrievals

Select the "quality" of the retrieval – higher provides greater confidence in results but reduces the number of retrievals – based on the number of camera pairs returning similar results and threshold on similarity

Select which cameras to match against the An camera – D cameras slow retrievals and are often not useful – for A cameras only, "Lowest retrieval precision" is needed

If cursor hovers over buttons, context-sensitive help is shown

Digitize Plumes – 3a



- While you are in "Digitize" mode, you can continue digitizing plumes
- Once each AGP, GP_GMP or other MISR product is loaded, there are no more load data prompts

① Using the mouse, left-click a point you choose to be the origin or source of the plume

② Left-click additional points to define the boundary of the plume – a dashed line segment will connect each successive pair of points

③ Digitize the last point to coincide with the origin point – this automatically closes the polygon and assigns a unique name to the plume

④ If you selected "Use no wind direction" in the "Digitizing Options" dialog, then go to ⑤
If you chose "Provide wind direction", then:

a) Left-click one or more additional points to define a wind vector – a dashed line connects the points

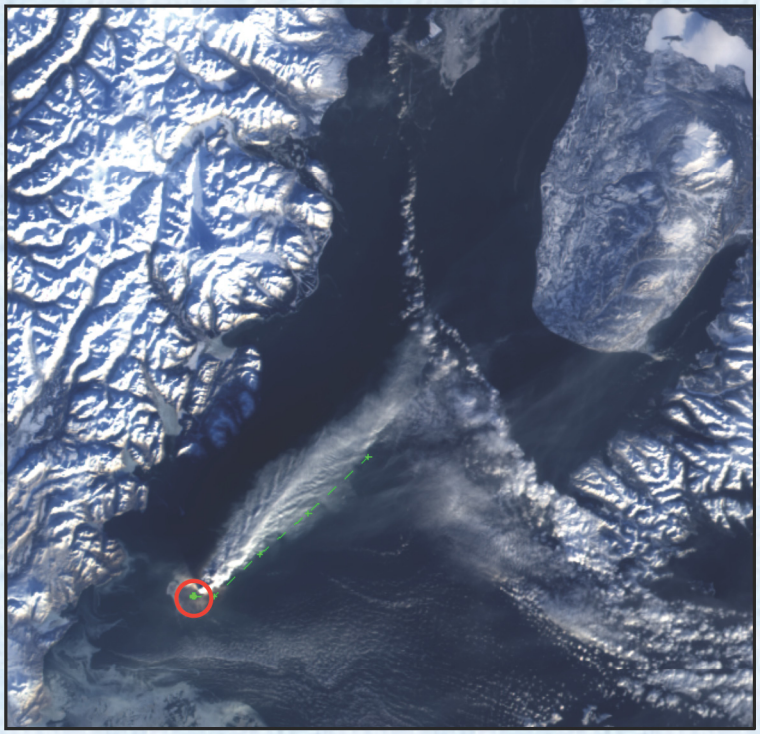
b) Right-click anywhere in window when done

⑤ Select the AGP and GP_GMP product files to load when the dialog boxes prompt for them

⑥ The wind direction line will change to solid yellow and describe a splined curve – this signals that image matching and height retrieval are beginning

⑦ When calculations finish, results are displayed on the screen and are written to file

Digitize Plumes – 3b



- While you are in "Digitize" mode, you can continue digitizing plumes
- Once each AGP, GP_GMP or other MISR product is loaded, there are no more load data prompts

① Using the mouse, left-click a point you choose to be the origin or source of the plume

② Left-click additional points to define the boundary of the plume – a dashed line segment will connect each successive pair of points

③ Digitize the last point to coincide with the origin point – this automatically closes the polygon and assigns a unique name to the plume

④ If you selected "Use no wind direction" in the "Digitizing Options" dialog, then go to ⑤
If you chose "Provide wind direction", then:

a) Left-click one or more additional points to define a wind vector – a dashed line connects the points

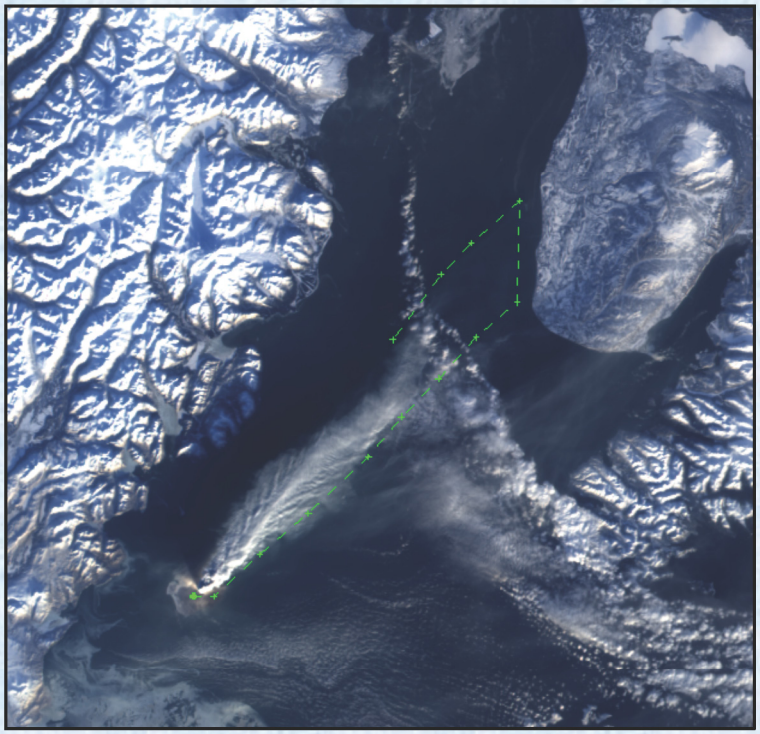
b) Right-click anywhere in window when done

⑤ Select the AGP and GP_GMP product files to load when the dialog boxes prompt for them

⑥ The wind direction line will change to solid yellow and describe a splined curve – this signals that image matching and height retrieval are beginning

⑦ When calculations finish, results are displayed on the screen and are written to file

Digitize Plumes – 3c



- While you are in "Digitize" mode, you can continue digitizing plumes
- Once each AGP, GP_GMP or other MISR product is loaded, there are no more load data prompts

① Using the mouse, left-click a point you choose to be the origin or source of the plume

② Left-click additional points to define the boundary of the plume – a dashed line segment will connect each successive pair of points

③ Digitize the last point to coincide with the origin point – this automatically closes the polygon and assigns a unique name to the plume

④ If you selected "Use no wind direction" in the "Digitizing Options" dialog, then go to ⑤
If you chose "Provide wind direction", then:

a) Left-click one or more additional points to define a wind vector – a dashed line connects the points

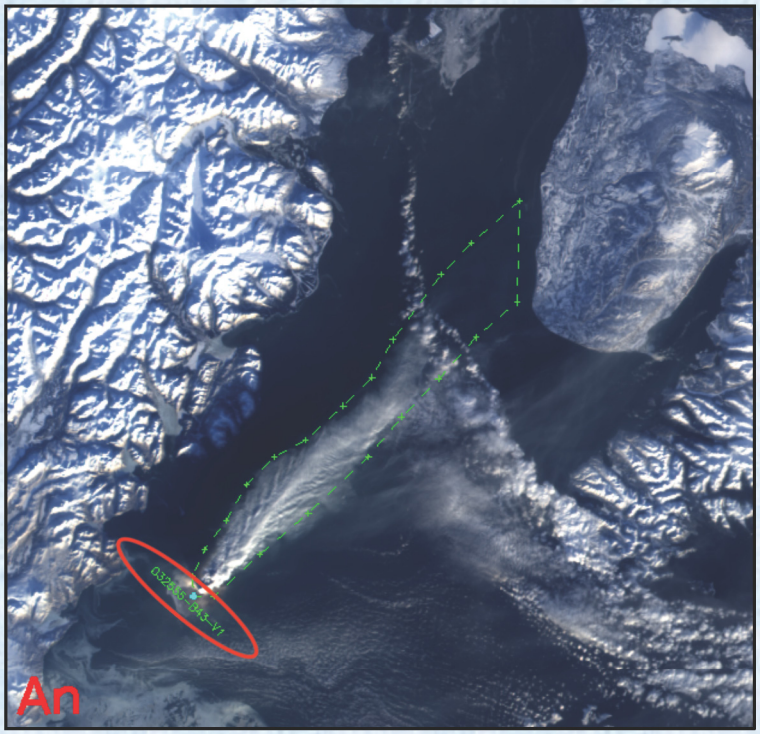
b) Right-click anywhere in window when done

⑤ Select the AGP and GP_GMP product files to load when the dialog boxes prompt for them

⑥ The wind direction line will change to solid yellow and describe a splined curve – this signals that image matching and height retrieval are beginning

⑦ When calculations finish, results are displayed on the screen and are written to file

Digitize Plumes – 3d



- While you are in "Digitize" mode, you can continue digitizing plumes
- Once each AGP, GP_GMP or other MISR product is loaded, there are no more load data prompts

① Using the mouse, left-click a point you choose to be the origin or source of the plume

② Left-click additional points to define the boundary of the plume – a dashed line segment will connect each successive pair of points

③ Digitize the last point to coincide with the origin point – this automatically closes the polygon and assigns a unique name to the plume

④ If you selected "Use no wind direction" in the "Digitizing Options" dialog, then go to ⑤
If you chose "Provide wind direction", then:

a) Left-click one or more additional points to define a wind vector – a dashed line connects the points

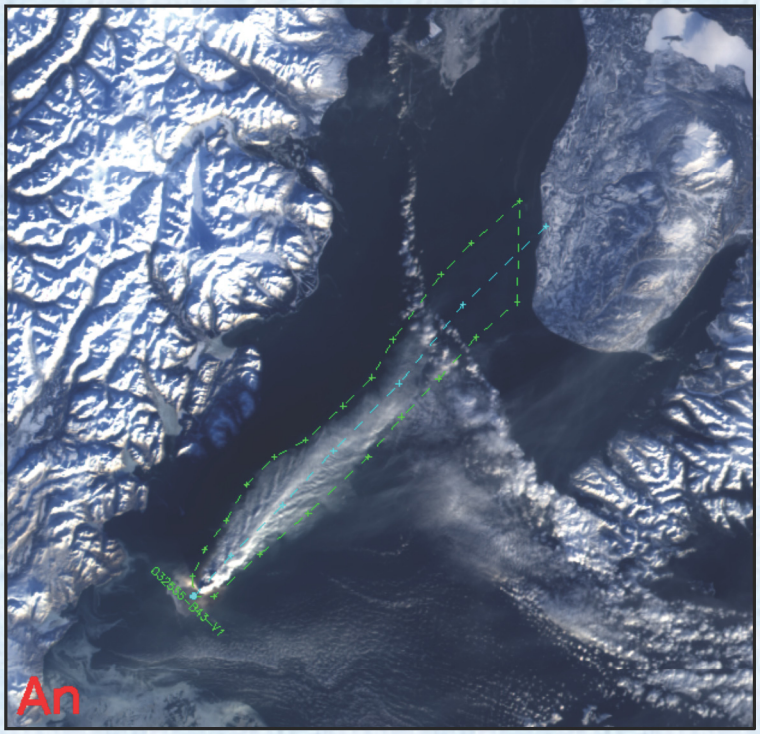
b) Right-click anywhere in window when done

⑤ Select the AGP and GP_GMP product files to load when the dialog boxes prompt for them

⑥ The wind direction line will change to solid yellow and describe a splined curve – this signals that image matching and height retrieval are beginning

⑦ When calculations finish, results are displayed on the screen and are written to file

Digitize Plumes – 3e



- While you are in "Digitize" mode, you can continue digitizing plumes
- Once each AGP, GP_GMP or other MISR product is loaded, there are no more load data prompts

① Using the mouse, left-click a point you choose to be the origin or source of the plume

② Left-click additional points to define the boundary of the plume – a dashed line segment will connect each successive pair of points

③ Digitize the last point to coincide with the origin point – this automatically closes the polygon and assigns a unique name to the plume

④ If you selected "Use no wind direction" in the "Digitizing Options" dialog, then go to ⑤
If you chose "Provide wind direction", then:

a) Left-click one or more additional points to define a wind vector – a dashed line connects the points

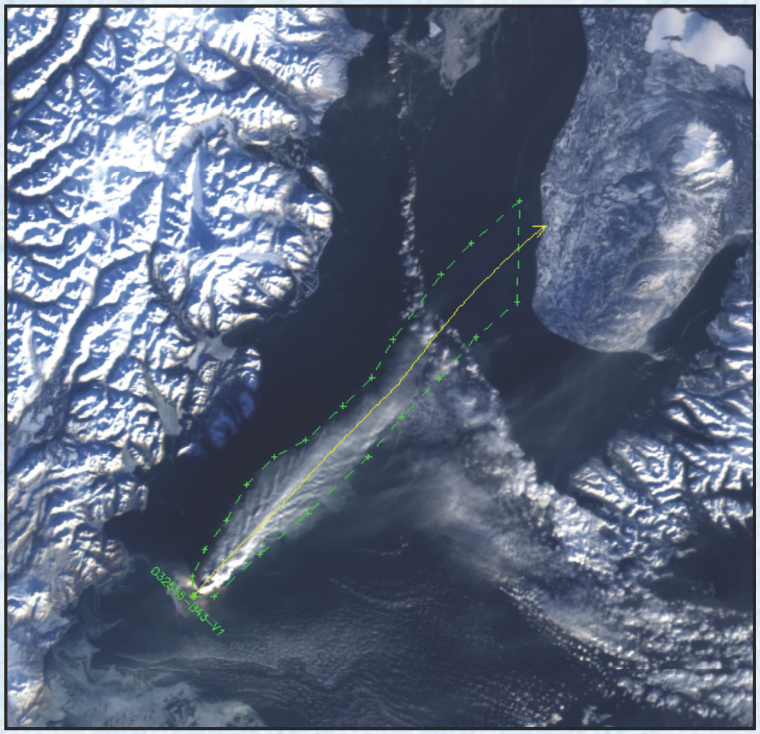
b) Right-click anywhere in window when done

⑤ Select the AGP and GP_GMP product files to load when the dialog boxes prompt for them

⑥ The wind direction line will change to solid yellow and describe a splined curve – this signals that image matching and height retrieval are beginning

⑦ When calculations finish, results are displayed on the screen and are written to file

Digitize Plumes – 3f



- While you are in "Digitize" mode, you can continue digitizing plumes
- Once each AGP, GP_GMP or other MISR product is loaded, there are no more load data prompts

① Using the mouse, left-click a point you choose to be the origin or source of the plume

② Left-click additional points to define the boundary of the plume – a dashed line segment will connect each successive pair of points

③ Digitize the last point to coincide with the origin point – this automatically closes the polygon and assigns a unique name to the plume

④ If you selected "Use no wind direction" in the "Digitizing Options" dialog, then go to ⑤
If you chose "Provide wind direction", then:

a) Left-click one or more additional points to define a wind vector – a dashed line connects the points

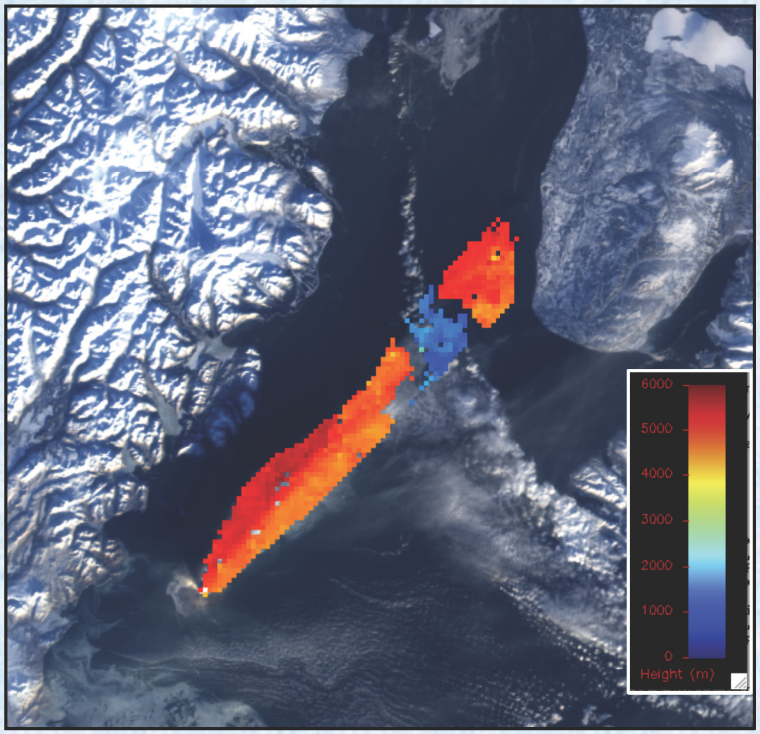
b) Right-click anywhere in window when done

⑤ Select the AGP and GP_GMP product files to load when the dialog boxes prompt for them

⑥ The wind direction line will change to solid yellow and describe a splined curve – this signals that image matching and height retrieval are beginning

⑦ When calculations finish, results are displayed on the screen and are written to file

Digitize Plumes – 3g



- While you are in "Digitize" mode, you can continue digitizing plumes
- Once each AGP, GP_GMP or other MISR product is loaded, there are no more load data prompts

① Using the mouse, left-click a point you choose to be the origin or source of the plume

② Left-click additional points to define the boundary of the plume – a dashed line segment will connect each successive pair of points

③ Digitize the last point to coincide with the origin point – this automatically closes the polygon and assigns a unique name to the plume

④ If you selected "Use no wind direction" in the "Digitizing Options" dialog, then go to ⑤
If you chose "Provide wind direction", then:

a) Left-click one or more additional points to define a wind vector – a dashed line connects the points

b) Right-click anywhere in window when done

⑤ Select the AGP and GP_GMP product files to load when the dialog boxes prompt for them

⑥ The wind direction line will change to solid yellow and describe a splined curve – this signals that image matching and height retrieval are beginning

⑦ When calculations finish, results are displayed on the screen and are written to file

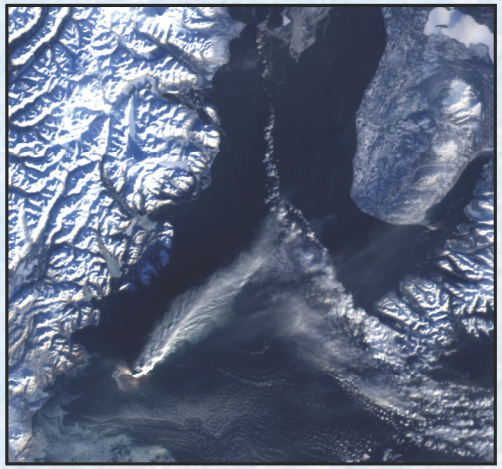
Contents

- Parallax, disparity and image matching
- Height/wind retrieval algorithm
- MINX height retrieval comparisons
- Digitizing procedure
- Evaluating results

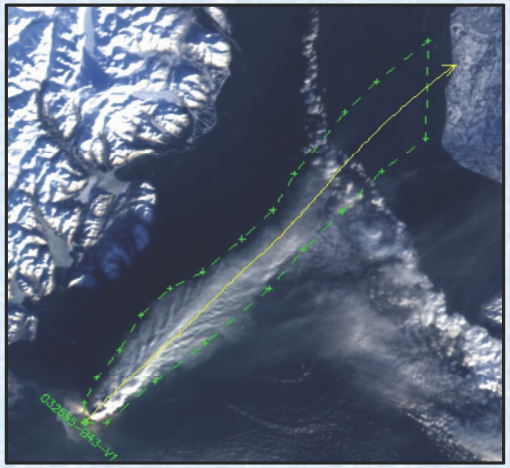
Evaluate Results - 1

Objective: To determine whether the heights and winds for the digitized feature are reasonable and acceptable or whether it should be redigitized or discarded.

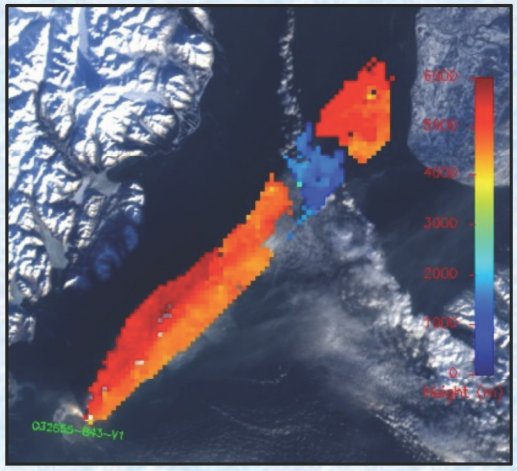
- For each aerosol feature digitized, MINX produces 3 map-view images (see below), 2 profiles, 2 histograms and 1 text file containing raw data point information
- All 8 files are automatically saved in a sub-directory in user's home directory named "0<orbit number>" e.g. "/Users/dlnelson/032555/"
- The MPEG camera animation file is created only if you have an IDL license – otherwise MINX will create 9 JPEG images
- Several images are also displayed on-screen for post-digitizing evaluation



9-camera animation



Digitized plume polygon and wind direction arrow



Color-coded retrieved heights

Evaluate Results - 2

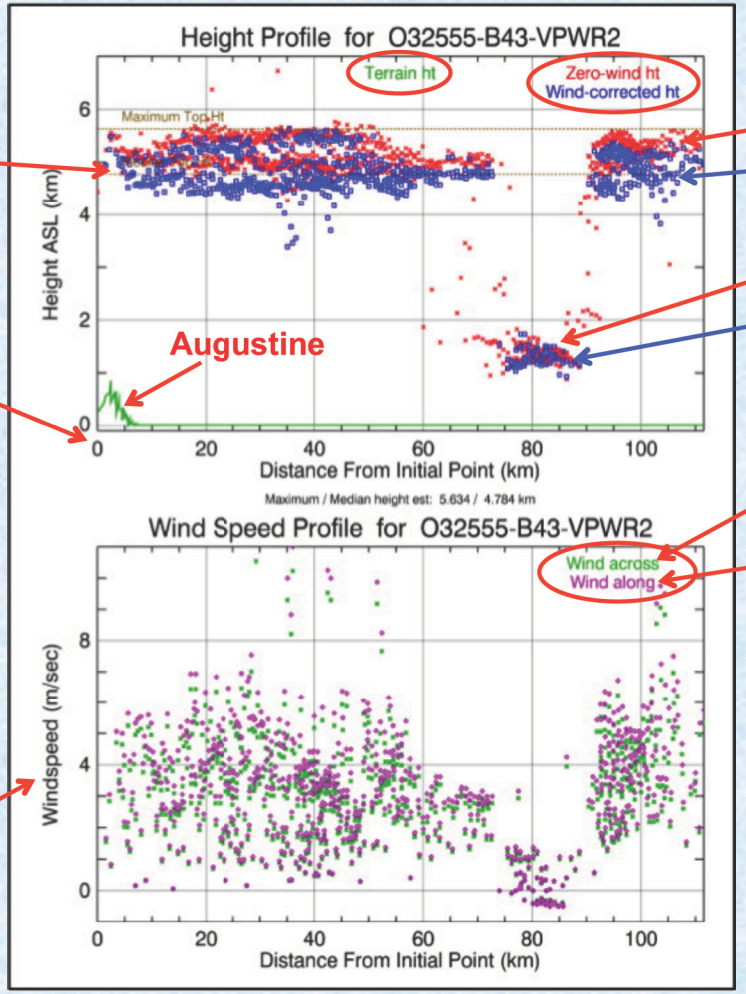
Some of apparent scatter in heights is due to multiple data points at same distance from origin

Distance = 0 on profiles corresponds to the first point digitized, so profiles may appear reversed from map view

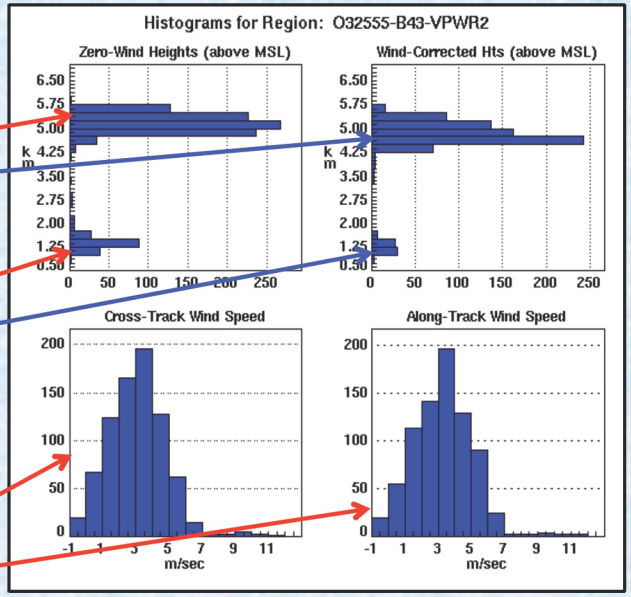
Total wind speed is :

SQRT(wind_across^2 + wind_along^2)

Wind speed along-track is positive toward the top of MISR orbits; wind speed across-track is positive toward the right



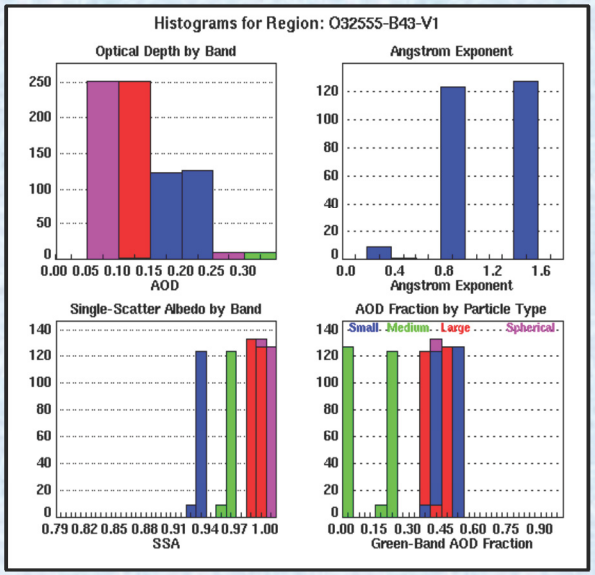
Height and wind profiles



Height and wind histograms

- The Height Profile is the most important graphic for evaluating the success and validity of the retrieval
- If "Use no wind direction" was selected in "Digitizing Options" dialog, then only the Height Profile and the Zero-Wind Heights histogram will be populated

Evaluate Results - 3



Header records in raw data file

Aerosol parameter histograms (retrieved from MISR standard aerosol product)

```
Orbit number    : 32555
Path number     : 69
Block number    : 43
Date acquired   : 2006-01-30
UTC time        : 21:30:35
MINX version    : V2.0
User name       : dlnelson
Date digitized  : 2012-04-10

Region name             : O32555-B43-VPWR2
Region aerosol type     : Volcanic ash
Region geometry type    : Polygon
Region wind dir type    : Direction provided
Retrieved with band     : Red
Match blue in An only?  : No
Match with blue-bandx?  : No
Retrieved with matcher  : Medium
Retrieved with cameras  : A B C D
Retrieval precision     : Medium
Images in "true color"  : No

First point longitude   :  -153.47194
First point latitude    :    59.35468
Perimeter length (km)   :   243
Area (sq km)            :  1453
Area per point (sq km)  :     1.210
Wind-corrected points   :   787
Percent area covered    :    66
Best median ht (m ASL)  :  4784
Best top ht (m ASL)     :  5634
StdDev metric, corrht   :   227
|WndDir-AlongDir|(deg)  :    43
Power of fire in MW     :    NA
Retrieval quality       :  GOOD

Level 1 radiance file   : MISR_AM1_GRP_TERRAIN_GM_P069_O032555_AN_F03_0024.hdf
Terrain elevation file  : MISR_AM1_AGP_P069_F01_24.hdf
Cam/Sun Geometry file   : MISR_AM1_GP_GMP_P069_O032555_F03_0013.hdf
SVM Classifiers file    : Not Loaded
Aerosol product file    : MISR_AM1_AS_AEROSOL_P069_O032555_F12_0022.hdf
```

New naming convention in MINX V2.0

New in MINX V2.0

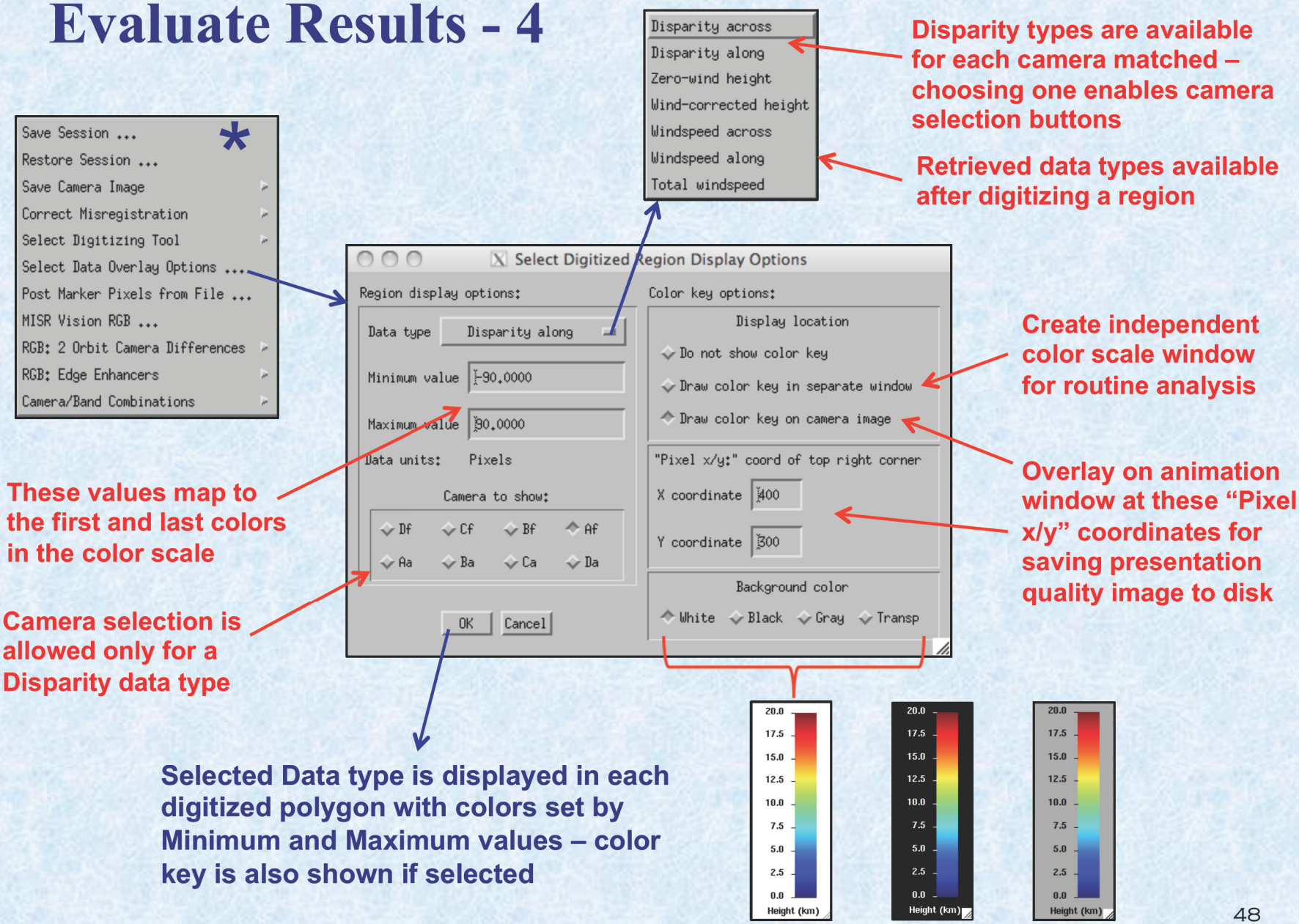
V2.0 also records the points defining the polygon and the wind direction (not shown)

Data-point table in raw data file (file is truncated across and down)

RESULTS: 1199 points in this table are samples where NoWnd heights or fire power were retrieved.

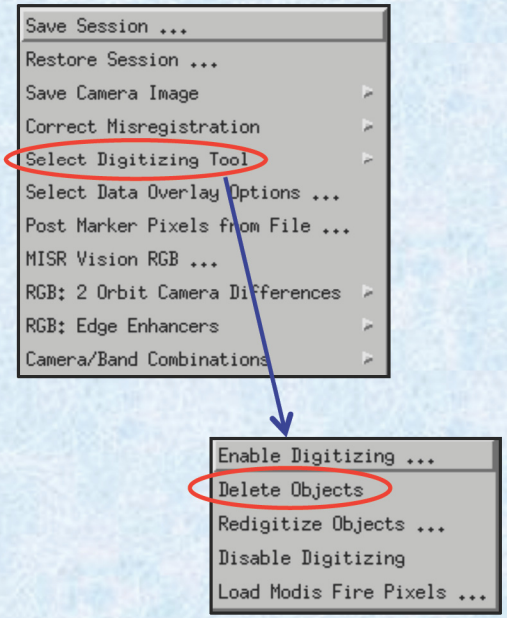
Pt#	Long-itude	Lat-itude	Blk	Samp	Line	Km to Pt 1	Dg Cw Rel N	Terr Elev	Feature Ht (m) NoWnd	Feature Ht (m) W/Wnd	Feature Ht (m) Fltrd	Windspeed (m/s) Across	Windspeed (m/s) Along	Windspeed (m/s) Total	Albedo by Band Blue	Albedo by Band Green	Albedo by Band Red	Albedo by Band NIR	BB TOA Albedo	Optical Depth by Band Blue	Optical Depth by Band Green	Optical Depth by Band Red	Optical Depth by Band NIR
1	-153.471	59.357	43	555	201	0.0	55	250	4768	-99	-99	-99.9	-99.9	-99.9	0.53	0.35	0.35	0.38	0.30	-9.999	-9.999	-9.999	-9.999
2	-153.433	59.398	43	558	182	5.1	55	27	5074	5187	-99	4.4	4.9	6.6	0.52	0.33	0.36	0.37	0.29	-9.999	-9.999	-9.999	-9.999
3	-153.437	59.389	43	558	186	4.0	55	101	4694	-99	-99	-99.9	-99.9	-99.9	0.52	0.34	0.35	0.40	0.30	-9.999	-9.999	-9.999	-9.999
4	-153.441	59.379	43	558	190	3.0	55	244	4864	-99	-99	-99.9	-99.9	-99.9	0.54	0.38	0.35	0.43	0.33	-9.999	-9.999	-9.999	-9.999
5	-153.446	59.369	43	558	194	2.0	55	447	5403	-99	-99	-99.9	-99.9	-99.9	0.51	0.32	0.34	0.33	0.27	-9.999	-9.999	-9.999	-9.999
6	-153.450	59.360	43	558	198	1.2	55	579	5083	5121	-99	1.8	2.0	2.7	0.54	0.36	0.41	0.44	0.32	-9.999	-9.999	-9.999	-9.999
7	-153.401	59.425	43	563	170	8.5	55	12	1033	-99	-99	-99.9	-99.9	-99.9	-99.99	-99.99	-99.99	-99.99	-99.99	-9.999	-9.999	-9.999	-9.999
8	-153.406	59.415	43	563	174	7.5	55	11	5324	5174	-99	1.0	1.2	1.6	0.42	0.26	0.41	0.26	0.19	-9.999	-9.999	-9.999	-9.999
9	-153.410	59.406	43	563	178	6.4	55	12	5064	-99	-99	-99.9	-99.9	-99.9	0.59	0.43	0.55	0.56	0.36	-9.999	-9.999	-9.999	-9.999
10	-153.414	59.396	43	563	182	5.4	55	40	5041	4578	-99	2.7	3.0	4.0	0.58	0.43	0.59	0.53	0.35	-9.999	-9.999	-9.999	-9.999
11	-153.418	59.387	43	563	186	4.4	55	137	5062	5050	-99	2.2	2.5	3.4	0.63	0.48	0.65	0.62	0.39	-9.999	-9.999	-9.999	-9.999
12	-153.423	59.377	43	563	190	3.5	55	320	5345	4870	-99	4.9	5.4	7.3	0.53	0.36	0.40	0.40	0.30	-9.999	-9.999	-9.999	-9.999
13	-153.427	59.367	43	563	194	2.8	55	618	5469	5456	-99	1.4	1.6	2.1	0.57	0.39	0.43	0.44	0.33	-9.999	-9.999	-9.999	-9.999
14	-153.431	59.358	43	563	198	2.3	55	860	5531	5568	-99	1.5	1.6	2.2	0.65	0.49	0.54	0.59	0.41	-9.999	-9.999	-9.999	-9.999
15	-153.374	59.442	43	566	162	11.0	55	12	4356	4556	-99	3.0	3.4	4.5	0.55	0.37	0.56	0.42	0.28	-9.999	-9.999	-9.999	-9.999
16	-153.378	59.432	43	566	166	9.9	55	12	1484	-99	-99	-99.9	-99.9	-99.9	0.57	0.44	0.44	0.48	0.35	-9.999	-9.999	-9.999	-9.999
17	-153.382	59.423	43	566	170	8.9	55	12	5144	4775	-99	4.0	4.5	6.1	0.61	0.47	0.56	0.61	0.40	-9.999	-9.999	-9.999	-9.999
18	-153.387	59.413	43	566	174	7.9	55	11	5115	4565	-99	9.7	10.8	14.5	0.57	0.40	0.47	0.50	0.34	-9.999	-9.999	-9.999	-9.999
19	-153.391	59.404	43	566	178	6.9	55	11	5021	4496	-99	2.5	2.8	3.7	0.59	0.43	0.60	0.54	0.35	-9.999	-9.999	-9.999	-9.999

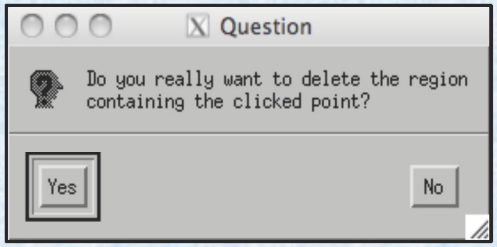
Evaluate Results - 4



Evaluate Results – Delete Plume

- To delete a region (plume, cloud or line):
  - ① Select "Delete Objects" from "Select Digitizing Tool" submenu
  - ② Left-click in or on any region
  - ③ Click "Yes" in the dialog box to confirm the operation
  - ④ You remain in "Delete" mode until you select a different menu option
- Deleting removes the image and text files from disk, from the animation window and from memory
- The deleted region name is reused by the next region you digitize in the same block
- If several regions overlap and you click in their intersection, the earliest region digitized will be deleted
- MINX makes it possible to experiment: you may want to digitize, delete and redigitize a region numerous times to determine the best bounding polygon, wind direction and digitizing parameters





Digitized Region Naming Convention

O49787-B68-SPNB3 - typical region name in MINX V2.0

O49787 - MISR orbit number

B68 - MISR block number where first point was digitized

SPNB - region identifier assigned by MINX based on user's selections in Digitizing Options dialog box (see table below)

3 - unique region identifier incremented for each new region in a block

Key to Region Identifier Letters

Letter 1: region aerosol type	Letter 2: region geometry type	Letter 3: wind direction specified by user?	Letter 4: band used in height retrieval
D = Dust	L = Line	N = No wind provided ("cloud")	R = Red
S = Smoke	P = Polygon	W = Wind provided ("plume")	G = Green
V = Volcanic ash			B = Blue
W = Water			N = NIR

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